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(72) Inventors:
• Oka, Kenichiro, c/o MNitsubishi Denki
Chiyoda-ku, Tokyo 100-8310 (JP)
• Suzuki, Hiroyoshi, c/o MNitsubishi Denki
Chiyoda-ku, Tokyo 100-8310 (JP)

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(74) Representative: Tothill, John Paul
Frank B. Dehn & Co.
179 Queen Victoria Street
London EC4V 4EL (GB)

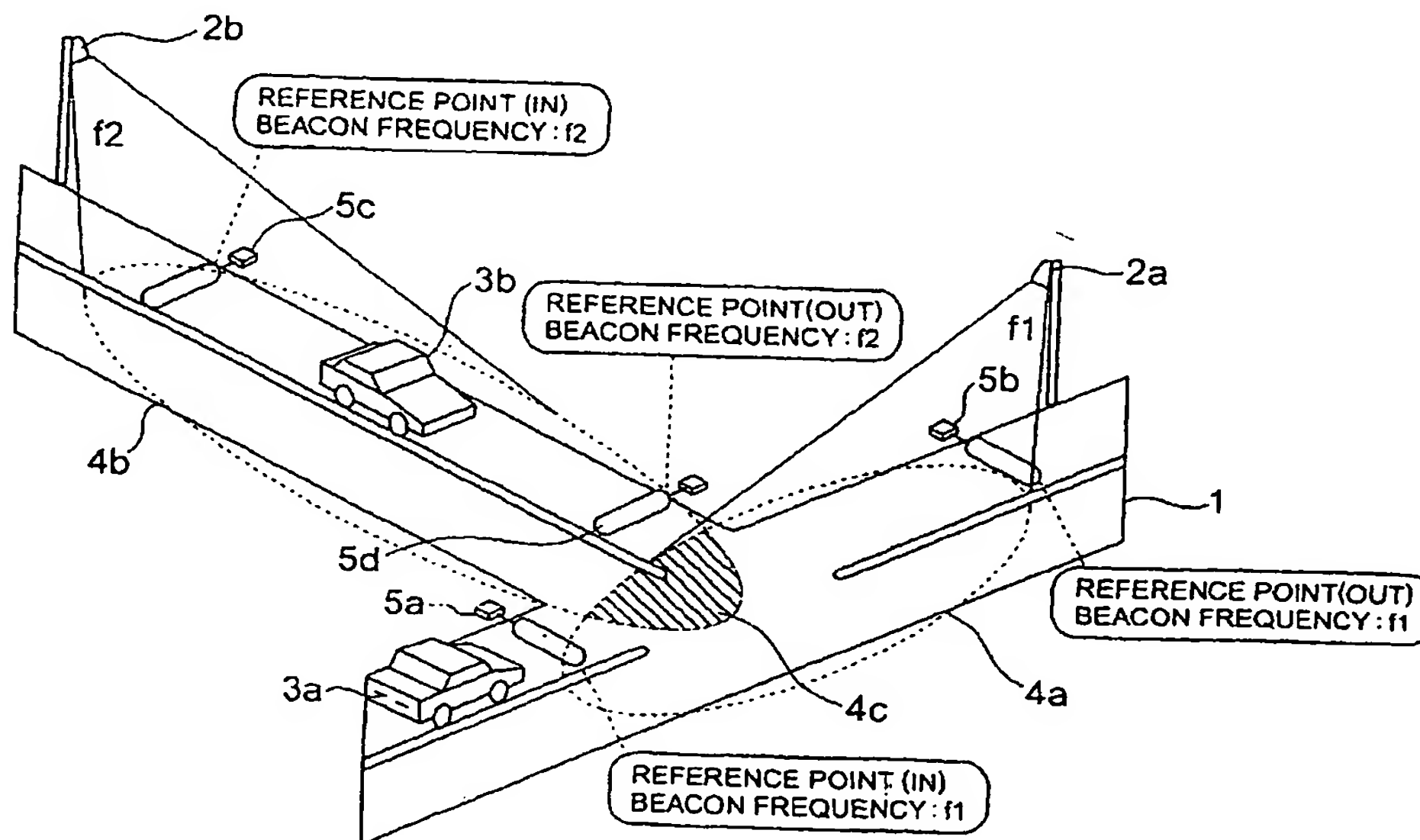
(71) Applicant: Director General of National Institute
for Land and Infrastructure Management,
Ministry of Land, Infrastructure and Transport
Tsukuba City, Ibaraki Prefecture 305-0804 (JP)

(54) On-road reference point positional data delivery device

(57) The on-road reference point positional data delivery device according to the present invention has a reference point positional data delivery means, and this reference point positional data delivery device has a

beacon identification means for indicating a reference point position for service information delivered from a beacon provided on a road to a vehicle and also selecting the beacon delivering the service information from among a plurality of beacons.

FIG. 1



Description

[0001] This invention relates to a reference point data delivery device for providing vehicles running on a road with various types of information.

[0002] The situation in which a vehicle running on a road receives service information from the road through road-to-vehicle communication from beacons installed on the road is as shown in Fig. 20. Beacons 2a, 2b installed on a road 1 offer different service information respectively via a radio communication. A vehicle 3 running on the road can communicate with the beacon 2a in an area 4a, with the beacon 2b in an area 4b, and with the beacons 2a, 2b in an area 4c respectively.

[0003] The vehicle 3 has an in-vehicle unit for performing road-to-vehicle communication with the beacons 2a, 2b, and receives, when the vehicle enters a communication-enabled area, service information from each beacon through a narrow area communication. The service information offered by the beacons 2a, 2b includes, but is not limited to, information concerning an obstacle such as a disabled car or a falling object, information concerning a surface situation of road surface in front or weather conditions, information concerning traffic jams, information concerning road construction, information on running restriction, and information concerning a parking area.

[0004] With the system based on the conventional technology as described above, however, as road-to-vehicle communication is performed between beacons and a vehicle, information delivery is performed within a narrow area, and when it is necessary to provide such information as "There is a disabled car 500 m ahead" for indicating a point on the road in the traveling direction, where is the reference point can not be understood with a beacon having a relatively wide communication-enabled area. Further, when two types of beacons 2a, 2b offer different types of service information and the communication-enabled areas overlap to some extent, a vehicle having received the service information from the beacons can not correctly determine whether the respective service information relates to a situation in the traveling direction or not, and therefore the vehicle can not correctly receive the service.

[0005] It is an object of the present invention to provide an on-road reference point data delivery device which can solve the problems in the conventional technology as described above and enables a vehicle running on a road to select a beacon offering information to be fetched and also to precisely identify a position indicated in the service information.

[0006] It is another object of the present invention to provide an on-road reference point data delivery device which enables a vehicle running on a road to accurately receive service information even within a very short traveling distance and also to precisely detect a reference point corresponding to the delivered service information.

[0007] To achieve the objects described above, the on-road reference point data delivery device has a reference point data delivery means, and this reference point data delivery means indicates a reference point for the service information delivered from a beacon installed on a road by means of road-to-vehicle communication, and also has a beacon identification means which selects a beacon corresponding to the delivered service information from among a plurality of beacons.

[0008] As the on-road reference point data delivery device has the configuration and especially the beacon identification means as described above, the reference point data delivery means indicates a service reference point on a road for the service information delivered from a beacon, and in addition the beacon identification means selects and communicates with a beacon delivering the service information required by a vehicle, so that the on-road reference point data delivery device can precisely identify a position indicated by the service information depending on a position where the device receives the service information from the reference point data delivery means as a reference point.

[0009] Further the on-road reference point data delivery device according to the present invention comprises a road-to-vehicle communication radio beacon having a narrow communication area in the extending direction of the road and installed on a road for delivering at least data on a reference point distance between a reference point and a forward point indicated by frontward road information concerning, for instance, a leaner form of the road in the front direction or an absolute position on the road to a vehicle running in the communication area on the road, and a reference marker installed within a communication area of a road-to-vehicle communication radio beacon on a road for indicating a reference point distance of a reference point for an absolute position on the actual road, while in a vehicle a reception means for receiving signals from the road-to-vehicle communication radio beacon, a reference point marker detection means, and a reference point detection means for determining that the vehicle has entered a communication area of a road-to-vehicle communication radio beacon or passed over a reference point marker, also for determining the reference point marker which the vehicle has just passed over as a reference point.

[0010] With the configuration described above, the road-to-vehicle communication radio beacon delivers at least data concerning a reference point distance up to a point indicated by frontward road information such as a leaner form of the road in the front direction or a position on the road, and the reference point marker indicates a reference point distance or a reference point for an absolute position on the actual road, so that the vehicle receives the signals from a reception means loaded on the vehicle for receiving signals from the road-to-vehicle communication beacons and determines that the vehicle has entered a communication area of the

road-to-vehicle communication beacon, recognizes with the reference point detection means that the vehicle has passed over a reference point marker, and identifies a position of the reference point marker as a reference position. Therefore, the vehicle can accurately receive service information even within a very short traveling distance and also can precisely detect a reference point corresponding to the service information.

[0011] The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view showing general configuration of Example 1 in one embodiment of the present invention;

Fig. 2 is a perspective view showing a reference point data delivery means in Example 1 of the embodiment;

Fig. 3 is a flat view showing the reference point data delivery means in Example 2 of the embodiment;

Fig. 4 is a perspective view showing the reference point data delivery means in Example 3 of the embodiment;

Fig. 5 is a flat view showing the reference point data delivery means in Example 4 of the embodiment;

Fig. 6 is a flat view showing the reference point data delivery means in Example 5 of the embodiment;

Fig. 7 is a perspective view showing general configuration of Example 6 in the embodiment;

Fig. 8 is a perspective view showing general configuration of Example 7 in the embodiment;

Fig. 9 is a perspective view showing general configuration of Example 1 in another embodiment of the present invention;

Fig. 10 is an explanatory view showing magnetic field distribution on a zonal magnetic marker in the direction lateral direction against a lane in Example 1 above;

Fig. 11 is an explanatory view showing how a vehicle detects a lane marker based on a radio system and a magnetic zonal marker in Example 1 of the embodiment;

Fig. 12 is an explanatory view showing a magnetic field distribution of a magnetic zonal marker in the direction lateral against a lane in Example 2 of the embodiment;

Fig. 13 is an explanatory view showing how a vehicle detects a lane marker based on the radio system and a magnetic zonal marker in Example 2 of the present invention;

Fig. 14 is a view showing arrangement of reference point markers when a position marker with the same polarity is present in Embodiment 3 of the embodiment;

Fig. 15 is a flat view showing arrangement of reference point markers when a position marker with a different polarity is present in Example 3 of the embodiment;

Fig. 16 is an explanatory view showing a magnetic field distribution on a position marker in a direction in which the road extends in Example 3 of the embodiment;

Fig. 17 is an explanatory view showing a magnetic field distribution of a position marker in the direction lateral against a lane in Example 3 of the embodiment;

Fig. 18 is a flat view showing arrangement of reference point markers in a case where the reference point markers are formed with markers equivalent to the position markers respectively in Example 4 of the embodiment;

Fig. 19 is an explanatory view showing a magnetic field distribution in a direction against a lane in a case where the reference point markers are formed with markers equivalent to the position markers respectively in Example 4 of the embodiment; and

Fig. 20 is a perspective view showing general configuration of a beacon based on the conventional technology.

[0012] The embodiment shown in the figures is described below with reference to the examples shown in the drawings. Fig. 1 to Fig. 8 show one embodiment of the present invention. Fig. 1 and Fig. 2 show arrangement, in Example 1 of this embodiment, of beacons and reference point positional data delivery means near a confluence point of a road with a side road, and in this figure, designated at the reference numeral 1 is a road, at 2a and 2b road-to vehicle communication radio beacons each provided in the side of the road 1 or at a similar position and having a communication area 3 within a specified range on the road surface, at 3a and 3b vehicles, at 4a, 4b, and 4c areas where the vehicles can communicate with the beacons, and at 5a, 5b, 5c, and 5d lane markers based on the radio system as reference point positional data delivery means 5 respectively. As shown in Fig. 2, the reference point positional data delivery means 5 comprises an on-road processor section 6 and a transmission loop antenna section 7. The transmission loop antenna section 7 is buried in a surface of the road.

[0013] The on-road processor section 6 stores data to be notified to the vehicles 3a, 3b, and transmits the data from the transmission loop antenna section 7 by controlling communication with the vehicles. The loop antenna section 7 emits data signals with modulated electric waves to the vehicles 3a, 3b passing over it. The data transmitted from the lane markers 5a, 5b, 5c, and 5d as reference point positional data delivery means 5 to the vehicles 3a, 3b include, but are not limited to, for instance, corresponding beacon ID code, a marker type, a lane number of each vehicle, and a number of lanes.

[0014] A frequency for identifying each of the beacons 2a, 2b from which an information delivery service is received is allocated to the corresponding beacon identification code. A lane marker used as a reference point

is used not only in combination with a beacon, but independently for delivering information. In a case of routine information including only a small quantity of data, the lane marker for a reference point independently delivers the information. For instance, the lane marker delivers, information concerning a start point and an end point of a sharp bend as well as a start point and an end point of a reduced speed area. A start point and an end point of a zone are shown as marker types of service-IN and service-OUT respectively. When dynamic information from the outside such as information from an obstacle sensor, traffic information, or information on weather conditions is provided, the beacon provides the service information, and the lane marker for a reference marker plays a role of specifying the beacon. When the lane marker for a reference point is not combined with any beacon, the beacon identification code is null.

[0015] The vehicle 3a fetches, when it passes over the lane marker 5a based on the radio system, information with a radio wave marker detector loaded thereon. In this example, the lane marker sends electric waves as signals, so that the vehicle receives the electric waves. As reference point information, a start point of an information delivery service zone is indicated (as IN) by the beacon 2a. This point is also a start point for the positional information included in the information delivered by the beacon 2a. The vehicle 3a also reads from the lane marker 5a that a frequency of signals from the beacon 2a is f1.

[0016] After the vehicle 3a passes over the lane marker 5a, when it goes into a communication-enabled area 4a with the beacon 2a having the frequency of f1, the vehicle 3a communicates with the beacon 2a, and receives delivery of service information. Although the vehicle 3a passes through an area 4c where it can communicate also with the beacon 2b during running, as signals from the beacon 2b are transmitted with a different frequency f2, the vehicle does not receive service by the beacon 2b.

[0017] In a case where positional information such as "500 m ahead" is included in the information delivered from the beacon 2a, the vehicle 3a computes a current position from the position when it passes over the lane marker 5a as a reference point to determine how many meters the position indicated by the information of "500 m ahead" delivered from the beacon 2a is. The vehicle 3a replaces the distance with the computed distance and displays the service information on a display unit in the vehicle or alerts the driver of the information with, for instance, sounds.

[0018] When the vehicle 3a passes over the lane marker 5b, the vehicle 3a receives a signal indicating and end (OUT) of the service zone as reference point information from the beacon 2a. Upon reception of the signal OUT, communication with the beacon 2a is terminated. It is conceivable that, when the point indicated by the information of "500 m ahead" from the beacon 2a is still ahead, appropriate notification is provided to the

vehicle's driver updating the distance to the point with a display or sounds in the vehicle.

[0019] On the other hand, when the vehicle 3b passes over the lane marker 5c, the vehicle 3b receives information from the beacon 2b. A signal indicating start of an information delivery service zone (IN) is received as reference point information from the beacon 2b. This point is also a start point included in the information delivered from the beacon 2b. Also the vehicle 3b determines from the lane marker 5c that a frequency of the signal from the beacon 2a is f2.

[0020] When the vehicle 3b passes over the lane marker 5c and enters an area 4b where communication with the beacon 2b is enabled, the vehicle 3b starts communication with the beacon 2b at the frequency f2, and receives the service information delivered from the beacon 2b. While running, the vehicle 3b also passes through an area 4c where also communication with the beacon 2a is simultaneously enabled, as the beacon 2a works with the different frequency f1, the vehicle 3b does not receive service by the beacon 2a. The vehicle 3b also receives a signal indicating an end of the service zone by the beacon 2b (OUT) as reference point information when it passes over a lane marker 5d. With this, communication with the beacon 2b is terminated.

[0021] As described above, the vehicles 3a, 3b can selectively receive signals indicating reference points and frequencies for the particular beacons 2a, 2b, so that the vehicles 3a, 3b can receive only information from either one relating beacons 2a or 2b according to a lane on which the vehicle is running. In addition, the vehicles 3a, 3b can receive positional information included in the service information with high precision.

[0022] Although description of this example assumes a system in which a lane marker transmits electric waves, a system is allowable in which a lane marker reflects electric waves. In this case, a vehicle transmits electric waves to a road surface and receives the electric waves reflected from a lane marker, thus the same effect as that described above being achieved.

[0023] Fig. 3 shows an example of the reference point data delivery means 5 in which a lane marker for a reference marker is formed with a plurality of pieces of magnets. Zones comprising zonal magnets 8a, 8c buried with the N pole upward and those comprising magnets 8b, 8d buried with the S pole upward are provided in a lane 1 on the road 1. In this case, assuming that a vehicle has a magnetism detector loaded thereon and runs from the left-hand side to the right-hand side in the figure, when the vehicle passes over the magnets 8a, 8b, 8c, and 8d successively, the vehicle reads the code of "NSNS" by fetching detected data from the magnetism detector in the time course. If the frequency f1 is assigned to the code of "NSNS", the vehicle can determine that the beacon providing the current service works with the frequency f1 and that a service zone by the beacon has started. It is also possible to include, in addition to specification of a frequency, a marker type,

namely service IN or service OUT.

[0024] Fig. 4 shows an example in which a narrow area communication means is used as the reference point positional data delivery means 5 in Example 3. The reference point positional data delivery means 5 is a facility like the beacon 2 providing the service as described above, but the communication-enabled area is set to an extremely narrow area to use the means 5 as a start point. In this example, also like in Example 1 or 2, the reference point positional data delivery means 5 delivers the reference point information and a frequency of the beacon 2 to the vehicle 3. To prevent the vehicle 3 from failing in detection of the reference point positional data delivery means 5, a particular frequency is allocated to the reference point positional data delivery means 5. When the reference point positional data delivery means 5 and the beacon 2 for delivery of service information employ the same communication method, the detector loaded on the vehicle 3 can be used to communicate with both of the reference point positional data delivery means 5 and the beacon 2.

[0025] Fig. 5 shows an example in which the reference point positional data delivery mean 5 comprises a collection of a plurality of zonal bodies applied or adhered to a road surface in Example 4. In this example, there are two types of zonal bodies, one having a large width, and the other having a small width, and code is expressed with arrangement of the two types of zonal bodies. The code includes information concerning a frequency of the beacon, a marker type, or the like. Assuming that a camera is loaded on the vehicle, the vehicle camera can read code expressed by the reference point positional data delivery means 5 by photographing the collection of zonal bodies with the camera and processing the image. By analyzing the code, it is possible to take out information concerning a frequency of a beacon from which the service is received, a marker type or the like.

[0026] Fig. 6 shows an example in which the reference point positional data delivery means 5 comprises a collection of a plurality of zonal bodies like those used in Example 4, and there are various types of zonal bodies including those having a small width, those having a large width, long ones, short ones, those positioned at a center or along a side of a road, single ones each extending in a lateral direction of a lane, or pairs of parallel ones. With the various types of configurations as described above, the reference point positional data delivery means 5 can store therein a larger quantity of information in a restricted area as compared to Example 4.

[0027] Fig. 7 shows an example in which a plurality of beacons providing the same service information but working at different frequencies respectively are serially provided on a road. Fig. 7 shows an example in which three units of beacons 2a, 2b, 2c are serially provided and working at the frequencies of f1, f2, and f3. The reference point positional data delivery means is a lane

marker based on the radio system similar to that in Example 1, and reference point lane markers 5a, 5c for service IN and reference point lane markers 5b, 5d for service OUT are provided on two lanes respectively. The code generated by the reference point lane markers 5a, 5c for service IN includes a frequency of communication with the first beacon 2a. The first beacon 2a generates information including a frequency of f2 for the second beacon 2b, the second beacon 2b generates information including a frequency of f3 for the third beacon 2c, and the third beacon 2c generates information including no frequency data.

[0028] The vehicle 3a or 3b senses, when passing over the lane marker 5a or 5c, that communication with the beacon 2a at the frequency f1 has been enabled and sets the communication frequency to f1 to start communication with the beacon 2a. When communication with the beacon 2a in an area 4a has been finished, the vehicle 3a or 3b set the frequency to f2 obtained from the beacon 2a to start communication with the second beacon 2b and waits for establishment of the communication link. When the vehicle 3a or 3b enters an area 4b where communication with the second beacon 2b is enabled, the vehicle 3a or 3b receives the second service information from the beacon 2b and at the same time knows that a frequency of the third beacon 2c is f3. When communication with the beacon 2b has been finished, the vehicle 3a or 3b sets the frequency to f3, and when the vehicle 3a or 3b enters an area 4c where communication with the third beacon 2c is enabled, the vehicle 3a or 3b receives the third service information from the beacon 2c. At the same time, the vehicle 3a or 3b knows that there is no further beacon, and terminates communication with the beacons.

[0029] As described above, when the same service information is delivered from a plurality unit of beacons, the reference point positional data delivery means delivers information of a frequency of the first beacon, and each beacon provides information for a frequency of the following beacon, so that a vehicle can successively communicate with the beacons to correctly acquire service information.

[0030] Fig. 8 shows a case in Example 7 in which a plurality unit of beacons delivering the same service information but working at different frequencies respectively are provided serially on a road like in Example 6. In Fig. 8, three units of beacons 2a, 2b, and 2c are serially provided and work at the frequency of f1, f2, and f3. The reference point positional data delivery means is a lane marker based in the radio system like that in Example 1, and reference point lane markers 5a, 5c for service IN and reference point lane markers 5b, 5d for service OUT are provided in two lanes respectively. The code generated by the reference point lane markers 5a, 5c for service IN includes information for the frequencies f1, f2, f3 for communication with the beacons 2a, 2b, and 2c respectively as beacon array information. Therefore the vehicle can obtain service information correctly

by successively communicating with the beacons.

[0031] Fig. 9 to Fig. 19 show another embodiment of the present invention. Fig. 9 to Fig. 11 shows Example 1 of this embodiment. In Fig. 9, the reference numeral 15 indicates a reference point marker provided in each lane on a road surface within a communication area 14 for a radio beacon 12 for road-to-vehicle communication 15, and in this example the reference point marker 15 comprises a magnetic zonal marker which extends in a lateral direction of the lane. The reference numeral 13 indicates a vehicle, and the vehicle 13 comprises a reception means for signals from the radio beacon 12 for road-to-vehicle communications, a detection means for the magnetic zonal marker 15, and a reference position detection means. The radio beacon 12 for road-to-vehicle communications has a narrow communication area 14 with the width of at least several tens of meters so that a plurality of reference points are not present within this area.

[0032] In Fig. 10, the reference numeral 17 indicates a partition line of a lane on the road 1, and the magnetic zonal marker 15 has the length reaching a point near the partition line 17 in the lateral direction of the lane with the magnetic field distribution 18 in the lateral direction of the lane having substantially homogeneous magnetic field amplitude along the width of the lane.

[0033] In Fig. 11, designated at the reference numeral 15a is a cross-sectional form of the magnetic zonal marker 15 in the direction in which the road extends, at 19 a magnetic field distribution in the direction in which the road extends having the magnetic field amplitude in the vertical direction against the magnetic zonal marker 15, and at 19a a peak point of magnetic field and a reference point on the magnetic zonal marker 15 in the direction in which the road extends. Also in this figure, designated at the reference numeral 21 is a magnetism sensor detecting the magnetic field of the magnetic zonal marker 15 which forms a reference point marker detection means loaded on the vehicle 3 for detecting a magnetic field around the magnetic zonal marker 15, and at the reference numeral 22 a receiving antenna constituting a receiving means for the radio beacon 12 for road-to-vehicle communication. The magnetic sensor 21 is attached to a lower section in the front side of the vehicle, while the receiving antenna 22 is set inside the vehicle or attached to an upper section outside the vehicle. The reference numeral 23 indicates a in-vehicle detector comprising a receiving means for determining a communication area for the radio beacon 12 for road-to-vehicle communication based on an output from the receiving antenna 22 and a reference position detection means for detecting a position of a reference marker over which the vehicle passes based on an output from the magnetic sensor 21. The reference numeral 16 indicates a direction in which the vehicle is running.

[0034] In each of the figures described above, at first when the vehicle 13 runs on the road 1 in a direction 16 to the magnetic zonal marker 15 and enters the commu-

nication area 14 for the radio beacon 12 for road-to-vehicle communication, the vehicle 13 receives an electric wave from the radio beacon 12 for road-to-vehicle communication by the receiving antenna 22 with the received electric wave demodulated by the on-road detector 23, and determines that the communication has been established, and then the vehicle 12 receives information delivered from the radio beacon 12 for road-to-vehicle communication and indicating a distance from the reference point to a position indicated by information concerning a situation in the forward direction of the road such as a linear form of the direction or information indicating an absolute position on the road 1. The in-vehicle detector 23 on the vehicle 13 continuously measures the magnetic field amplitude in the vertical direction with the magnetism sensor 21 and detects a peak point 19a shown as a peak form when the vehicle 13 passes over the magnetic zonal marker 15 in the magnetic field distribution 19 in the direction in which the road extends.

[0035] When the peak point 19a is detected, the in-vehicle detector 23 determines that the position corresponding to the peak point 19a on which the vehicle 13 has passed is within the communication area 14 for the radio beacon 12 for road-to-vehicle communication and further that the peak point is the first peak point 19a detected at first after the vehicle 13 entered the communication area 14, and recognizes the point corresponding to the peak point as a reference position in a direction in which the road extends. On the other hand, when there is (are) other peak point(s) within the communication area 14, the in-vehicle detector 23 aborts the data. The vehicle 13 recognizes the position corresponding to the peak point 19a detected by the in-vehicle detector 23 as a reference point for the reference point distance delivered from the radio beacon 12 for road-to-vehicle communication or an absolute position on the road.

[0036] It is better to use a two-axial magnetism sensor which can detect the magnetic field amplitudes along the two axial directions, namely an amplitude of the magnetic field B_z in the vertical direction and an amplitude of the magnetic field B_x in the lateral direction of the lane as the magnetism sensor 21 to identify the magnetic zonal marker 15, and when the peak point 19a is detected from the amplitude of the magnetic field B_z in the vertical direction, the magnetism sensor 21 determines that the amplitude of the magnetic field B_x in the lateral direction of the lane is substantially zero, and also that the vehicle 13 has passed over the magnetic zonal marker 15.

[0037] In this example, a distance from a reference point to a point indicated by information concerning a situation in the front side of the road 1 such as a linear form of the road 1 or information concerning an absolute position on the road 1 is delivered from the radio beacon 12 for road-to-vehicle communication, and at the same time a point corresponding to the peak point 19a in the magnetic field B_z in the vertical direction for the first

magnetic zonal marker 15 in the communication area 14 on the road 1 is used as a reference point for the information in a direction in which the road 1 extends, and therefore the vehicle 13 can accurately receive service information even within a small traveling distance and can advantageously detect a reference point for the service information with high precision.

[0038] In this example, further reference point positional data is delivered via the magnetic zonal marker 15 to separate an information delivery means from the reference point positional data delivery means, and information delivery is performed by the radio beacon 12 for road-to-vehicle communication, and therefore it is advantageously possible to deliver a vast quantity of information including not only information concerning a reference point, but also other information relating to the delivered service.

[0039] Fig. 12 and Fig. 13 show Example 2 of the embodiment described above. In Fig. 12, the reference numeral 30 indicates a lane marker based on the radio system, which is like the lane markers 5a to 5d each based on the radio system in the embodiment of the present invention shown in Fig. 2. The reference numeral 31 indicates a transmission loop antenna section for the lane marker 30 buried in the road 1, and the transmission loop antenna section insures a communication area up to both edges of the lane by using a loop antenna which extends along the width of the lane. The reference numeral 32 indicates a road side processor for the lane marker 30 to transmit electric waves from the antenna section 31 to over the road surface, and the antenna section 31 and the road side processor 32 are connected to each other with an electric cable.

[0040] In Fig. 13, the reference numeral 33 indicates a communication area by an electric wave transmitted from the antenna section 31 for the lane marker 30, and the magnetic zonal marker 15 is provided so that the peak point 19a in the magnetic field distribution 19 in the direction in which the road extends is within the communication area 33 as described above. The reference numeral 34 indicates a receiving antenna for a lane marker, which is attached to a lower section of the vehicle 13 in the front side thereof, and an output therefrom is given to the on-road detector 23.

[0041] In each of the figures above, the vehicle 13 runs in a direction 16 to the magnetic zonal marker 15, and at first when the vehicle 13 comes near the antenna section 31 for the lane marker 30 and enters the communication area 33, an electric wave from the lane marker 30 is received by the receiving antenna 34 of the vehicle 13 with the received electric wave demodulated by the on-road detector 23, the vehicle 13 determines that the communication with the lane marker 30 has been established, and receives information concerning a distance from a reference point up to a point indicated by information concerning a situation in the front direction of the road such as a linear form of the road 1 or information concerning an absolute position on the road

1. The in-vehicle detector 23 continuously measures an amplitude of the magnetic field in the vertical direction with the magnetism sensor 21, and detects the peak point 19a of the magnetic field distribution 19 in a direction in which the road extends.

[0042] Like in Example 1 described above, when the in-vehicle detector 23 detects the peak point 19a of the magnetic field distribution 19 in the direction in which the road extends and it is determination that a position corresponding to the peak point 19a is within the communication area 33 for the lane marker 30 and that the peak point 19a is the first one after the vehicle 13 enters the communication area 33, the point corresponding to the peak point 19a is regarded as a reference point in the direction in which the road extends. If it is determined that there is (are) other peak point(s) within the communication area, the information is aborted. The vehicle 13 recognizes the position corresponding to the peak point 19a detected by the in-vehicle detector 23 as a reference point for information delivered from the lane marker 30 or as a reference point for information concerning an absolute position on the road.

[0043] In this example, it is possible for the vehicle 13 to accurately receive service information within a small traveling distance and also to advantageously detect a reference point for the service information with high precision. Further lane marker 30 based on the radio system is used as a means for road-to-vehicle communication, so that, as compared to the radio beacon 12 for road-to-vehicle which is installed in the road side together with a pole, the cost is cheaper and different information can advantageously be delivered for each lane.

[0044] Fig. 14 to Fig. 17 show Example 3 of the embodiment. In Fig. 14, the reference numeral 36 indicates a position marker functioning as a positional reference in the lateral direction of a lane on the road 1, and this position marker comprises a magnetic marker consisting of a magnet buried in the road 1 with the N-pole side positioned upward. N-porous magnetic marker 36 and the magnetic zonal marker 15 as a reference point marker are present in the communication area 14 by the radio beacon 12 for road-to-vehicle communication. As for polarity of the magnetic zonal marker 15, the side closer to a surface of the road is S pole, so that the polarity is contrary to that of the N-polarity magnetic marker 36 functioning as a position marker 36. The N-polarity magnetic marker 36 has the magnetic field distribution 41 in a direction in which the road extends as shown in Fig. 16, and at the same time has the substantially same magnetic field distribution 42 also in the lateral direction of the lane as shown in Fig. 17. In contrast, the magnetic zonal marker 15 has, as shown in Fig. 13, the magnetic field distribution 19 in the direction in which the road extends which is substantially the same as the magnetic field distribution 41 by the position marker in the direction in which the road extends as shown in Fig. 16, and also has the homogeneous magnetic field distribution 18 in the lateral direction of the lane as shown in Fig. 10.

[0045] Further in Fig. 14, when the vehicle enters the communication area 14 by the radio beacon 12 for road-to-vehicle communication from the right-hand side in the figure, the magnetism sensor 21 loaded in the vehicle detects both the N-polarity magnetic marker 36 and the magnetic zonal marker 15. However, as a polarity of the magnetic zonal marker 15 functioning as a reference point is S pole, the in-vehicle detector 23 determines the polarity and detects only S pole to differentiate the reference point marker from the position marker, and recognizes a position of the magnetic zonal marker 15 functioning as a reference marker as a reference position.

[0046] Next, Fig. 15 shows a case in which the N-polarity magnetic markers 36 and S-polarity magnetic markers 37 are provided alternately as position markers. The S-polarity magnetic marker 37 has the same magnetic field distribution as that of the N-polarity magnetic marker 36, but the polarity of the former is contrary to that of the latter. As for polarity of the magnetic zonal marker 15, the side closer to a surface of the road is S pole, and the two magnetic zonal markers 15 are arranged in both sides from the N-polarity magnetic marker 36 at a specified space therebetween in the direction in which the road extends. The space between the two magnetic zonal markers 15 must be sufficient to identify the peak points 19a of the two magnetic field distributions 19 from each other. Also the space between the S-polarity magnetic marker 37 and magnetic zonal marker 15 adjoining each other must be sufficient to identify the two magnetic field distributions in the direction in which the road extends from each other.

[0047] In Fig. 15, when the vehicle enters the communication area 14 by the radio beacon 12 for road-to-vehicle communication from the right-hand side in the figure, the magnetism sensor 21 loaded in the vehicle detects the N-polarity magnetic marker 36, S-polarity magnetic marker 37, and magnetic zonal marker 15. However, the polarity sequence detected by the in-vehicle detector 23 when passing over the two magnetic markers 15 is "NN", and the polarity sequence when the position markers are successively detected is "SN", so that the in-vehicle detector 23 can identify the magnetic zonal markers 15 each as a reference point marker based on the difference in the polarity sequence as described above, and recognizes a position of the magnetic zonal marker 15 which is the latter one of the two magnetic zonal markers 15 as a reference position. Even when the vehicle snakes in a lane, detects the N-polarity magnetic marker 36 once, and then detects the N-polarity magnetic marker 36 again without detecting the S-polarity magnetic marker 37, the polarity sequence detected by the in-vehicle detector 23 is "NN", but the distance between the two N-polarity magnetic markers 15 detected in this case is substantially different from that detected in the ordinary running mode, and therefore the in-vehicle detector 23 determines by computing the distance between two points corresponding to the two peak points respectively based on a velocity of the vehicle

that a space between the two magnetic zonal markers 15 detected as "NN" in this case is different from that detected in the ordinary running mode, and aborts the data.

[0048] In this example, also the same advantages as those described in the example described above are provided, and by providing in a communication area by a radio beacon for road-to-vehicle communication reference point markers with the different polarity sequence from that of other magnetic markers also provided in the communication area, it is possible to advantageously and easily identify a reference point marker even when the reference point markers and magnetic markers for positional detection used for delivery of information on a positional reference in the lateral direction of a lane are present in the same communication area.

[0049] Although the radio beacon 12 for road-to-vehicle communication is used as an information delivery means in the example described above, a radio marker 30 may be provided adjacent to the magnetic zonal marker 15 for delivery of information.

[0050] Further it is needless to say that the S-polarity magnetic markers and N-polarity magnetic markers may be used in the reverse order in the example described above.

[0051] Fig. 18 and Fig. 19 show Example 4 of the embodiment. In Fig. 18, the reference point marker is formed by arranging a plurality of S-polarity magnetic markers 37 each functioning as a position marker along a straight line extending in the lateral direction of a lane, and as shown in Fig. 19, the S-polarity magnetic markers are arranged with a space therebetween so that the magnetic field distributions 44 in the lateral direction of the lane for each S-polarity magnetic markers form, when overlaid on each other, a substantially homogeneous magnetic field distribution 45 in the lateral direction of the lane.

[0052] The same effects as those described in the example described above can be achieved also in this example, and by using reference markers based on specifications similar to those of position markers used in mass, there is provided the advantage that the reference point markers can be prepared with low cost.

[0053] Description of the example above assumes a case where only the N-polarity magnetic marker 36 is present as a position marker, a position marker having another polarity may be used, and also the sequence of S-polarity and N-polarity magnetic markers may be reversed.

[0054] The examples of the two embodiments of the present invention are provided only to show presently preferable examples of the present invention, and it is needless to say that various changes and modifications are allowable according to the necessity within a scope of the present invention.

Claims

1. An on-road reference point positional data delivery device provided on a road for sending information to an in-vehicle detector loaded in a vehicle running on a road comprising:
 - a reference point positional data delivery means, wherein said reference point positional data delivery means indicates a reference point position for the service information delivered from a beacon provided on the road to the vehicle by means of road-to-vehicle communication and also has a beacon identification means for selecting a beacon sending said service information from among a plurality of beacons.
2. The on-road reference point positional data delivery device according to claim 1, wherein said reference point positional data delivery means is a lane marker provided on a road and the lane marker is completely buried in the road surface or a surface thereof is exposed on the road surface.
3. The on-road reference point positional data delivery device according to claim 2, wherein said lane marker transmits or reflects electric waves to deliver information to a vehicle.
4. The on-road reference point positional data delivery device according to claim 2, wherein said lane marker comprises a plurality of magnets arranged on a road with the S poles or N poles set to positions closer to a surface of the road, and information is delivered to a vehicle according to the sequence of S poles or of N poles.
5. The on-road reference point positional data delivery device according to any one of claims 1 to 4, wherein the reference point positional data delivery means is a dedicated short range communication having a communication zone for road-to-vehicle communication restricted to a prespecified small area in a direction in which the road extends.
6. The on-road reference point positional data delivery device according to any one of claims 1 to 4, wherein the reference point positional data delivery means comprises a collection of a plurality of zonal bodies applied on a surface of a road, and information is presented by a width of each zonal body or a sequence thereof.
7. The on-road reference point positional data delivery device according to any preceding claim further comprising a beacon identification means, wherein said beacon identification means is a frequency identification means which identifies a frequency of a beacon currently delivering service information from among a plurality of frequencies.
8. The on-road reference point positional data delivery device according to claim 7 further comprising a frequency identification means, wherein a plurality of beacons for delivering service information are successively provided, and when frequencies of the beacons are different from each other, said frequency identification means identifies a frequency of a beacon from which the service information for the vehicle to receive is delivered.
9. The on-road reference point positional data delivery device according to claim 7, wherein a plurality of beacons for delivering service information are successively provided, and when frequencies of the beacons are different from each other, a sequential number of a frequency for the vehicle to receive is assigned as sequence information to the service information.
10. An on-road reference point positional data delivery device provided on a road as well as in a vehicle comprising:
 - a radio beacon for road-to-vehicle communication provided on a road and having a narrow communication area in a direction in which a road extends for delivering information concerning a reference point distance from a reference point up to a point indicated by information concerning situations in the front direction along the road such as a linear form of the road or an absolute position on the road;
 - a reference point marker provided on a surface of the road within the communication area by said radio beacon for road-to-vehicle communication for indicating a reference position for said reference point distance or for an absolute position on the road surface;
 - a receiving means loaded in a vehicle for receiving signals from said radio beacon for road-to-vehicle communication;
 - a detection means loaded in the vehicle for detecting said reference point marker; and
 - a reference position detection means also loaded in the vehicle for determining that the vehicle has entered the communication area by said radio beacon for road-to-vehicle communication and then passed over the reference point marker and also for recognizing a position of said reference point marker as the reference position.
11. The on-road reference point positional data delivery device according to claim 10, wherein said radio beacon for road-to-vehicle communication is a lane

marker based on the radio system provided on a surface of a road and having a communication area within a specified range on the road surface.

12. The on-road reference point positional data delivery device according to claim 10, wherein said reference point marker is a magnetic marker solely provided within a communication range for said radio beacon for road-to-vehicle communication. 5
- 10
13. The on-road reference point positional data delivery device according to claim 10, wherein said reference point marker is a magnetic marker provided within a communication range for said radio beacon for road-to-vehicle communication and having a different polarity from that of another magnetic marker also provided in the communication range. 15
14. The on-road reference point positional data delivery device according to claim 10, wherein said reference point marker is a magnetic zonal marker which is lengthy in the lateral direction of a lane. 20

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FIG. 1

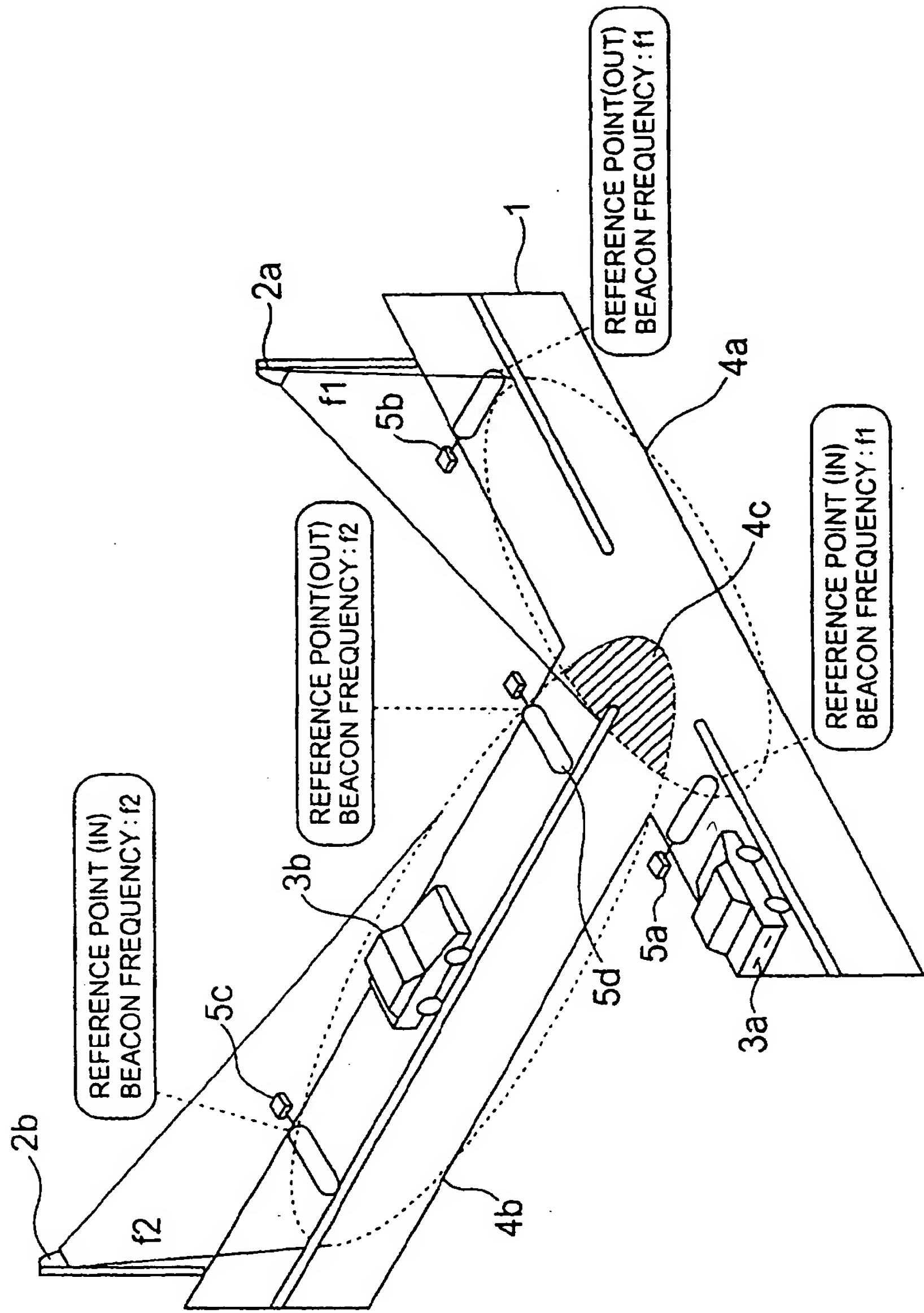


FIG. 2

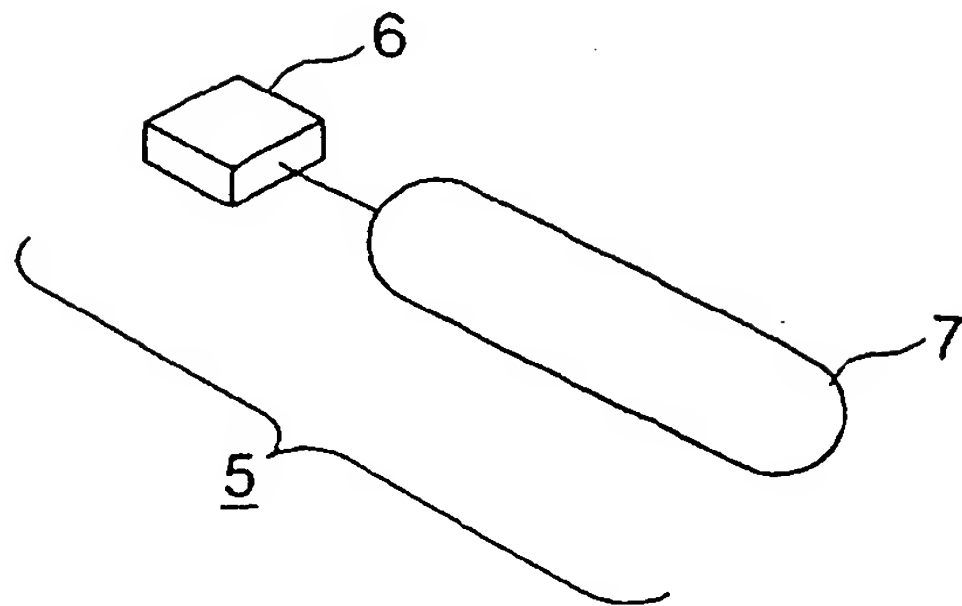


FIG. 3

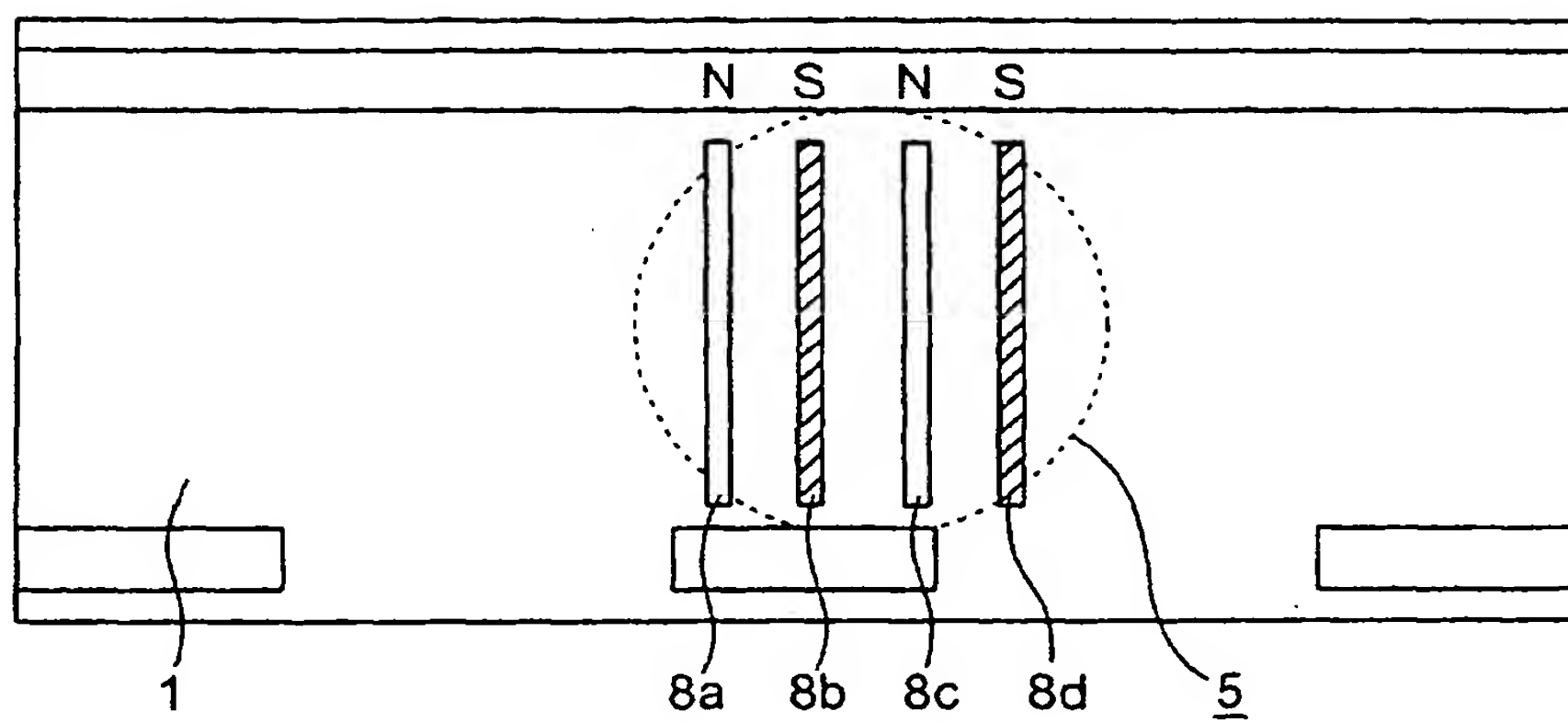


FIG. 4

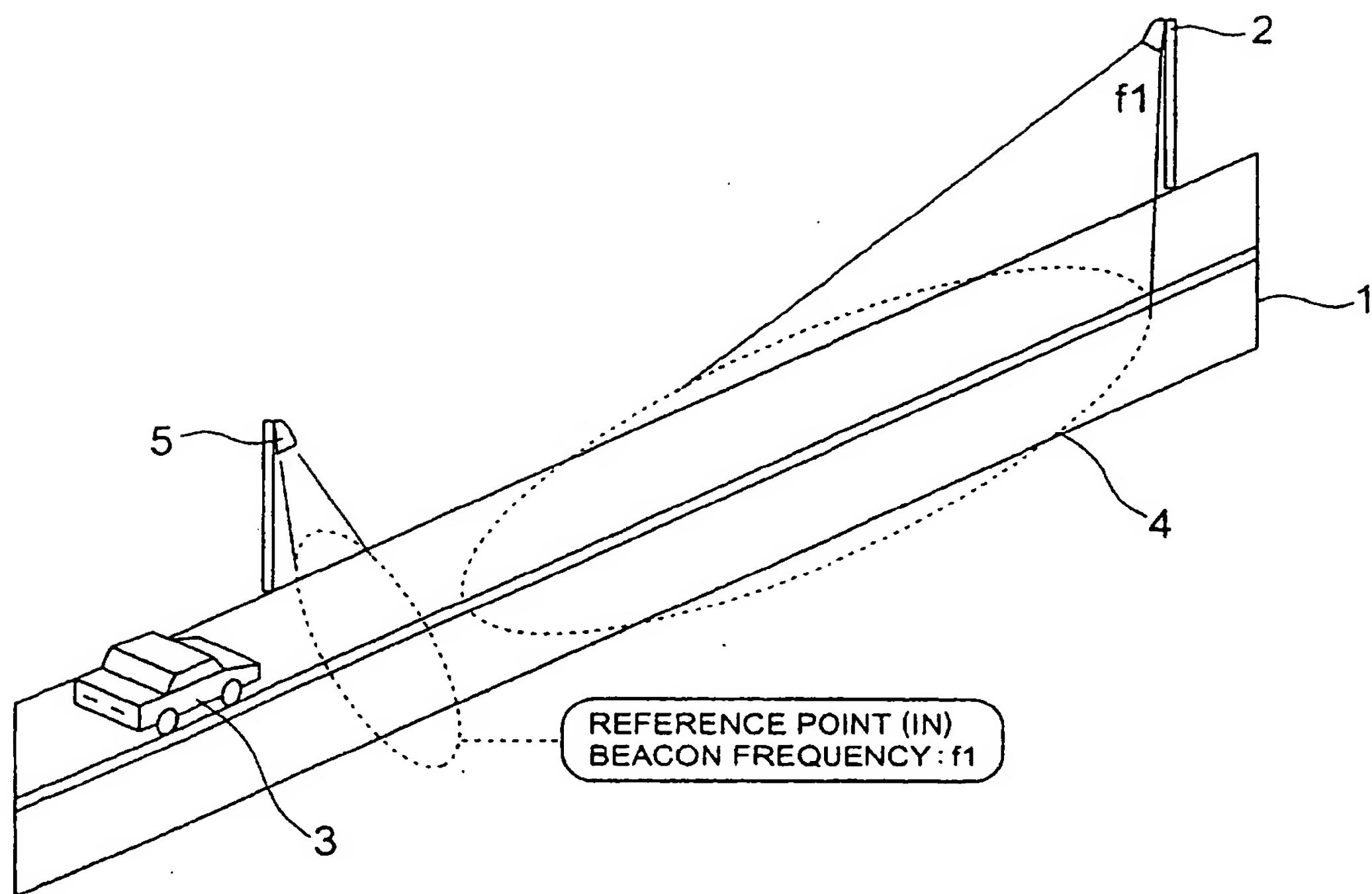


FIG. 5

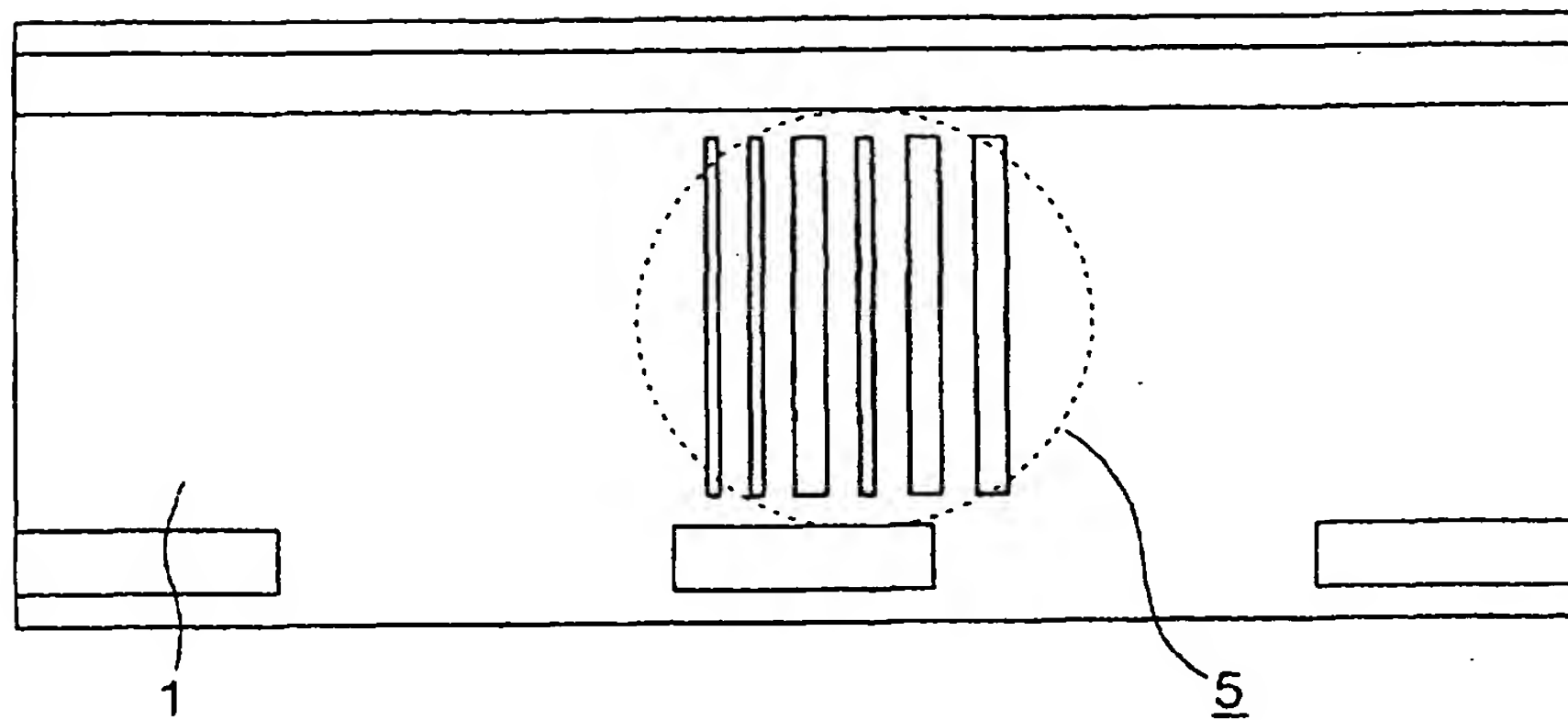


FIG. 6

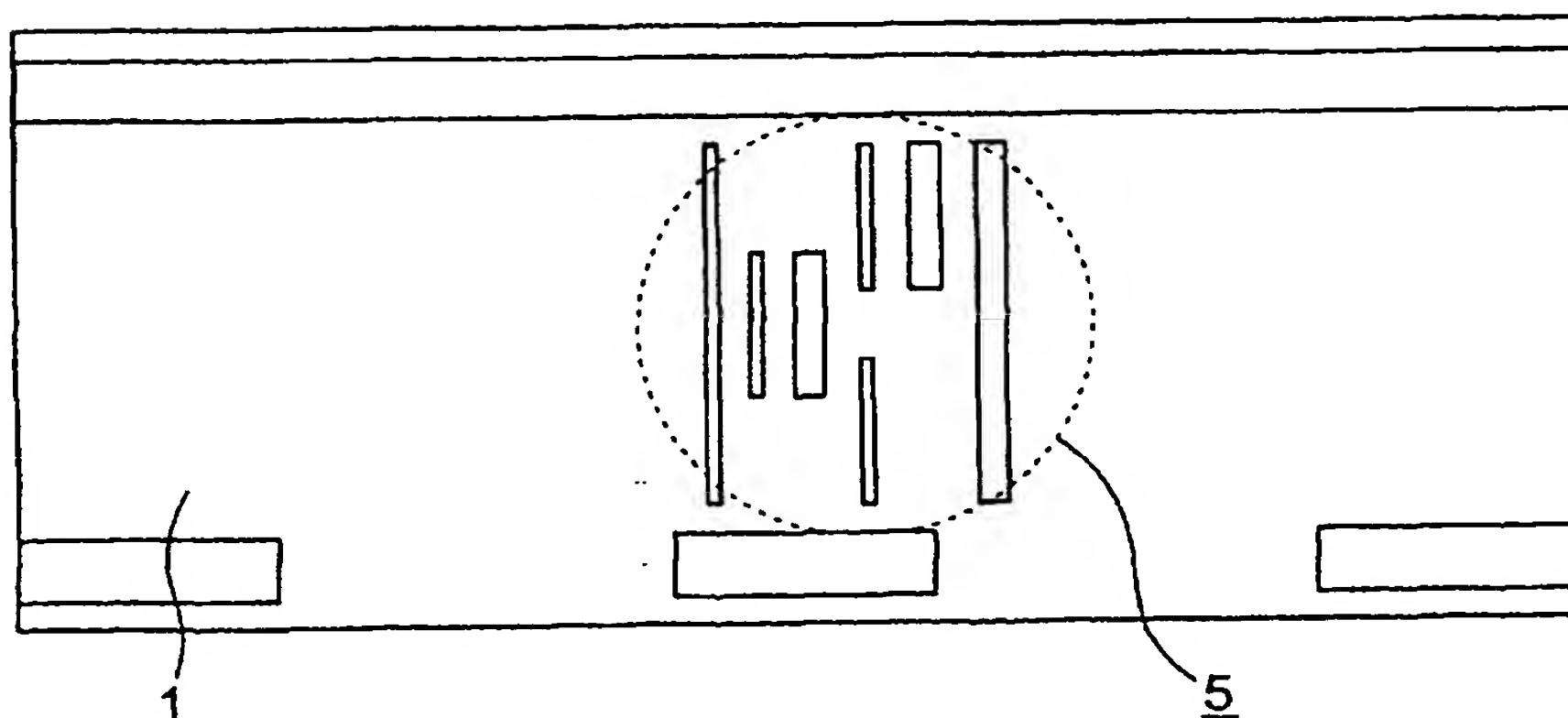


FIG. 7

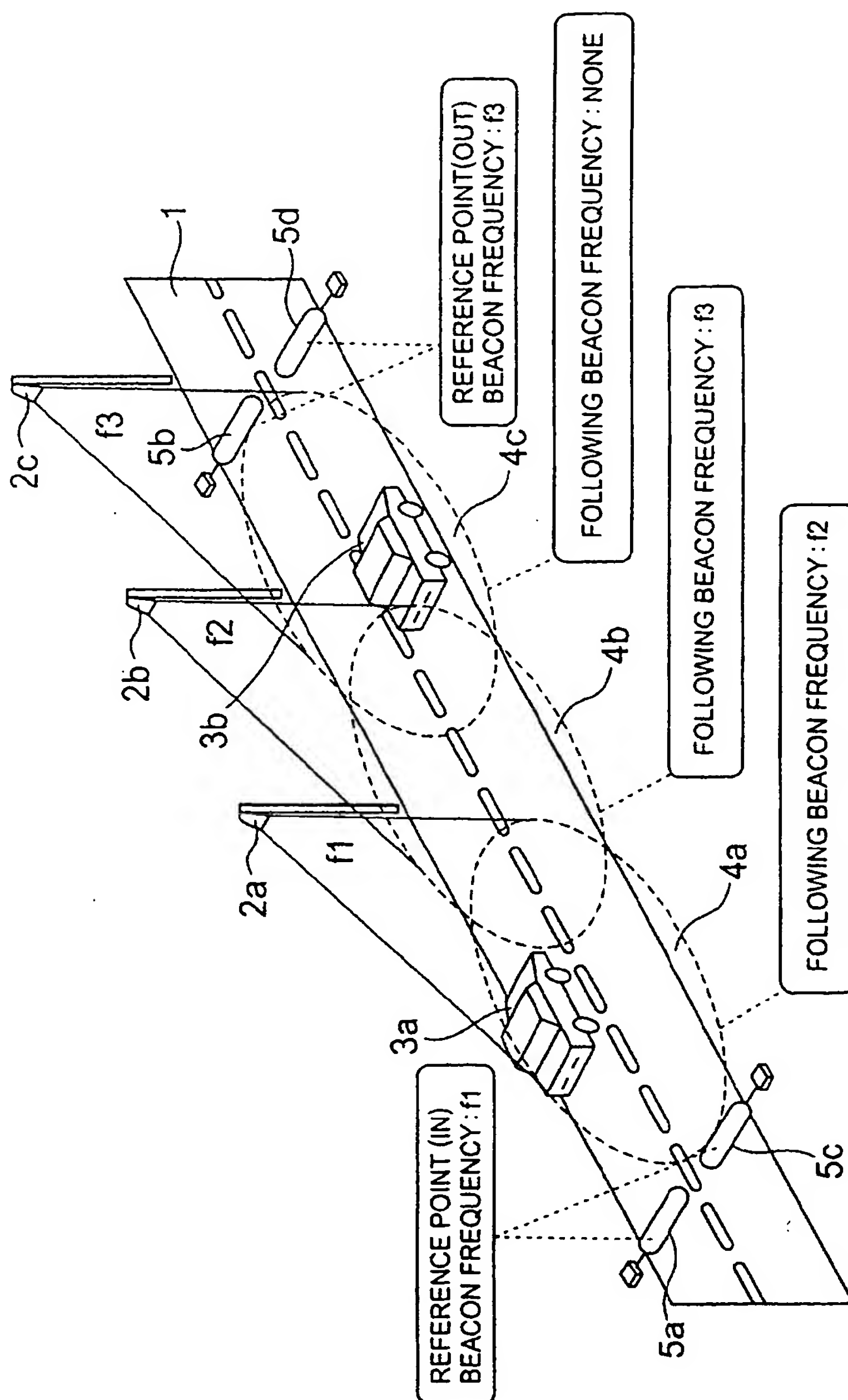


FIG. 8

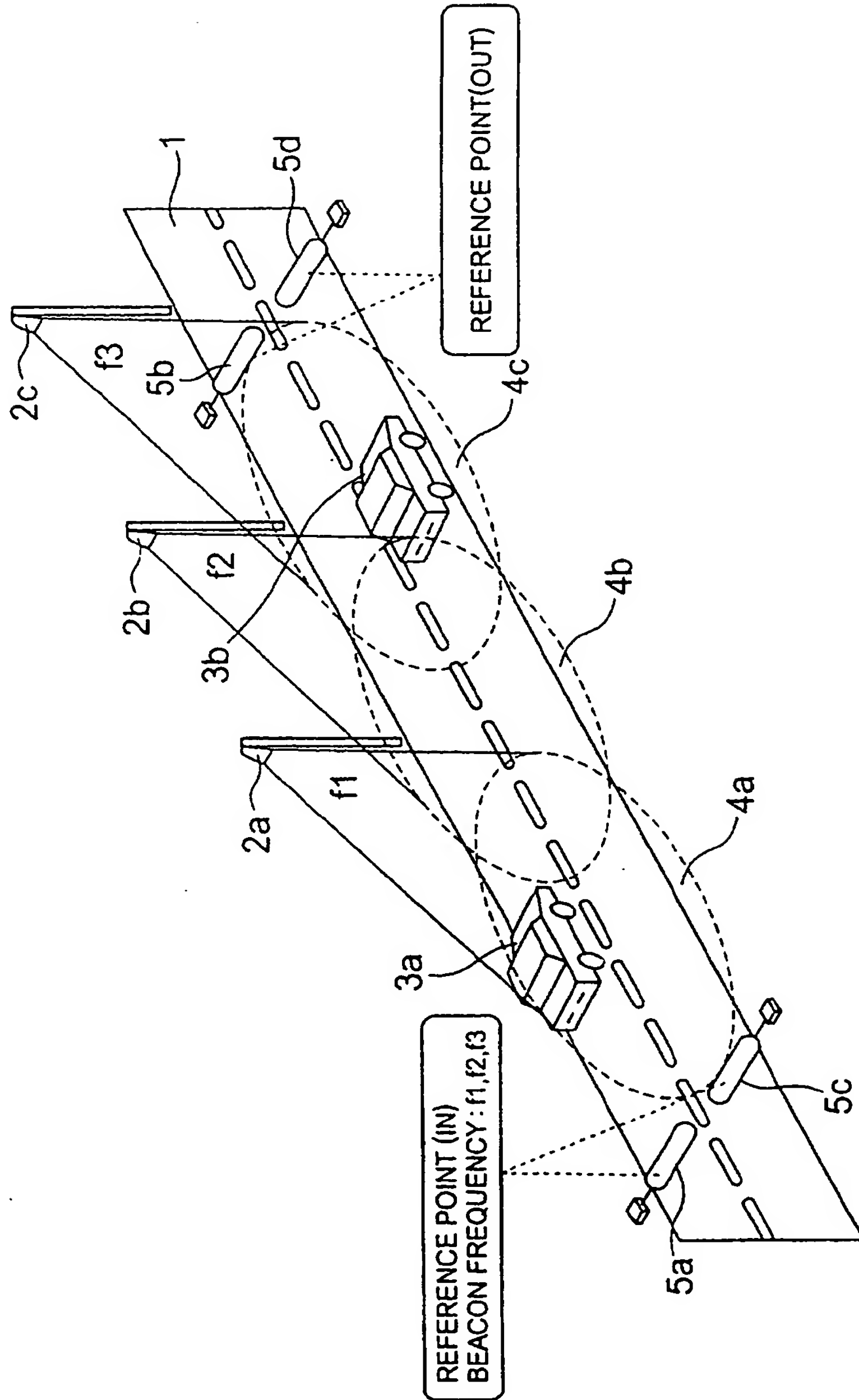


FIG. 9

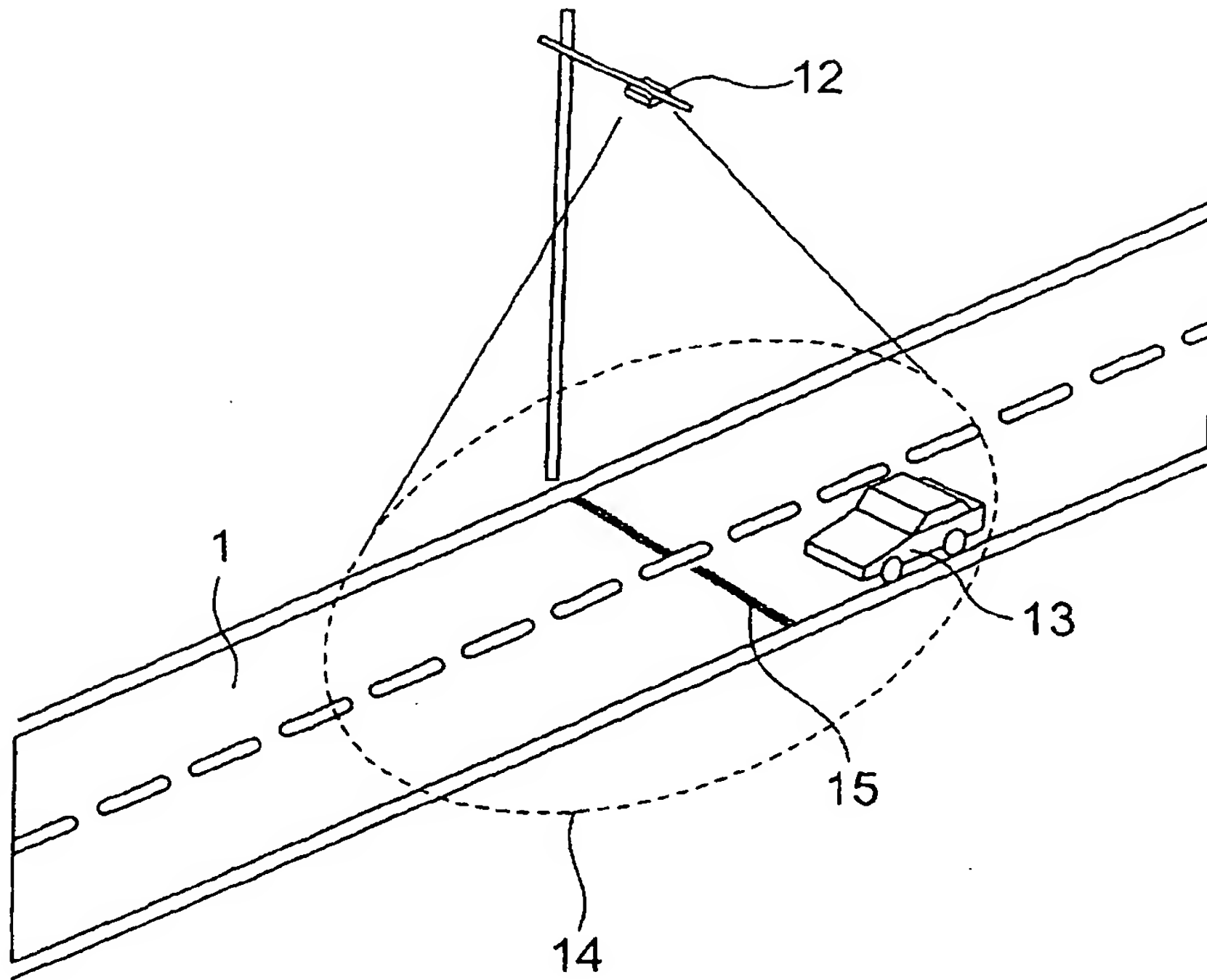


FIG. 10

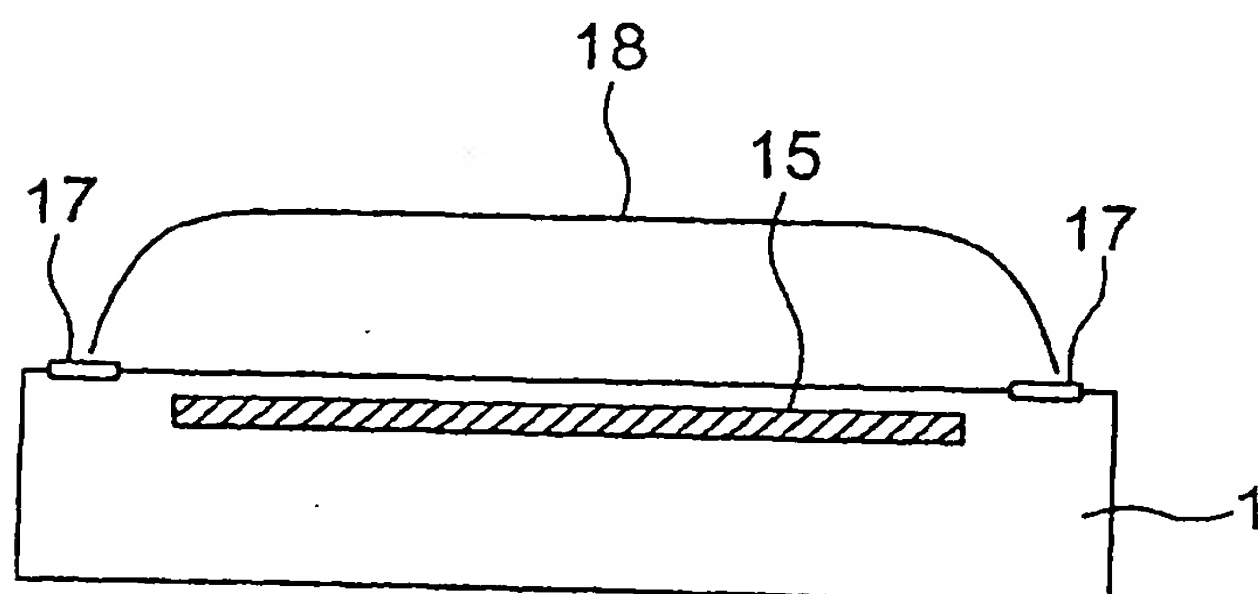


FIG. 11

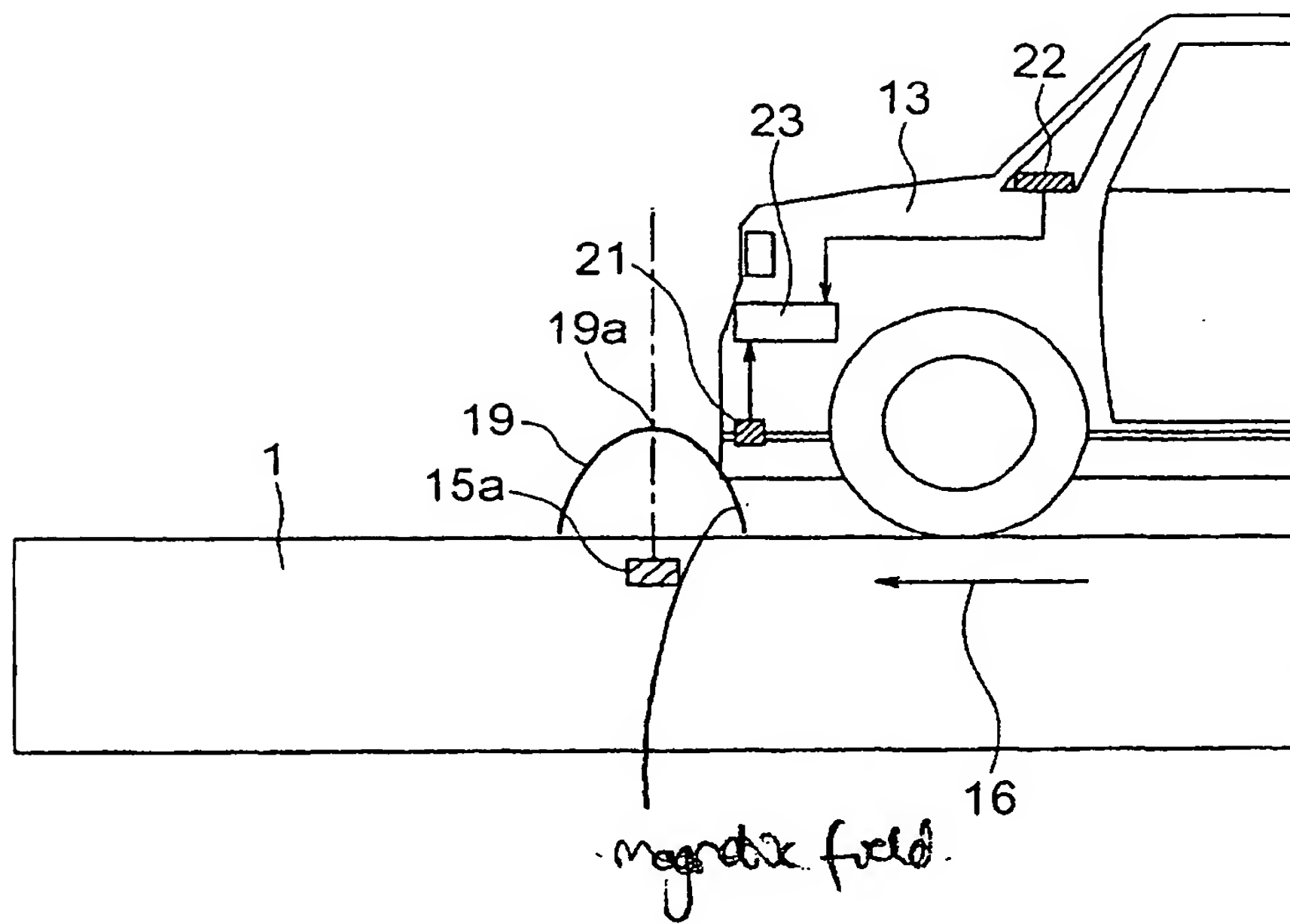


FIG. 12

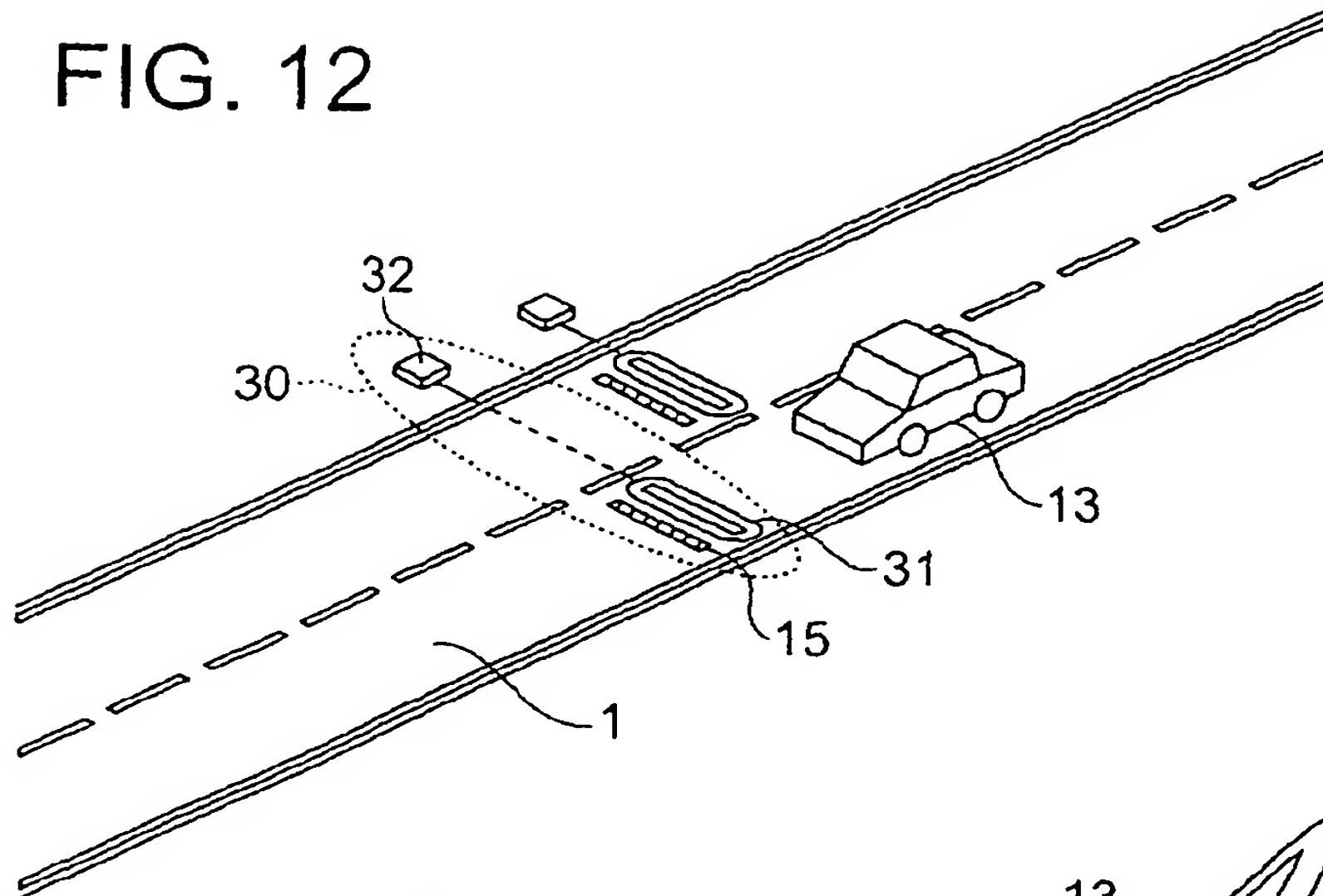


FIG. 13

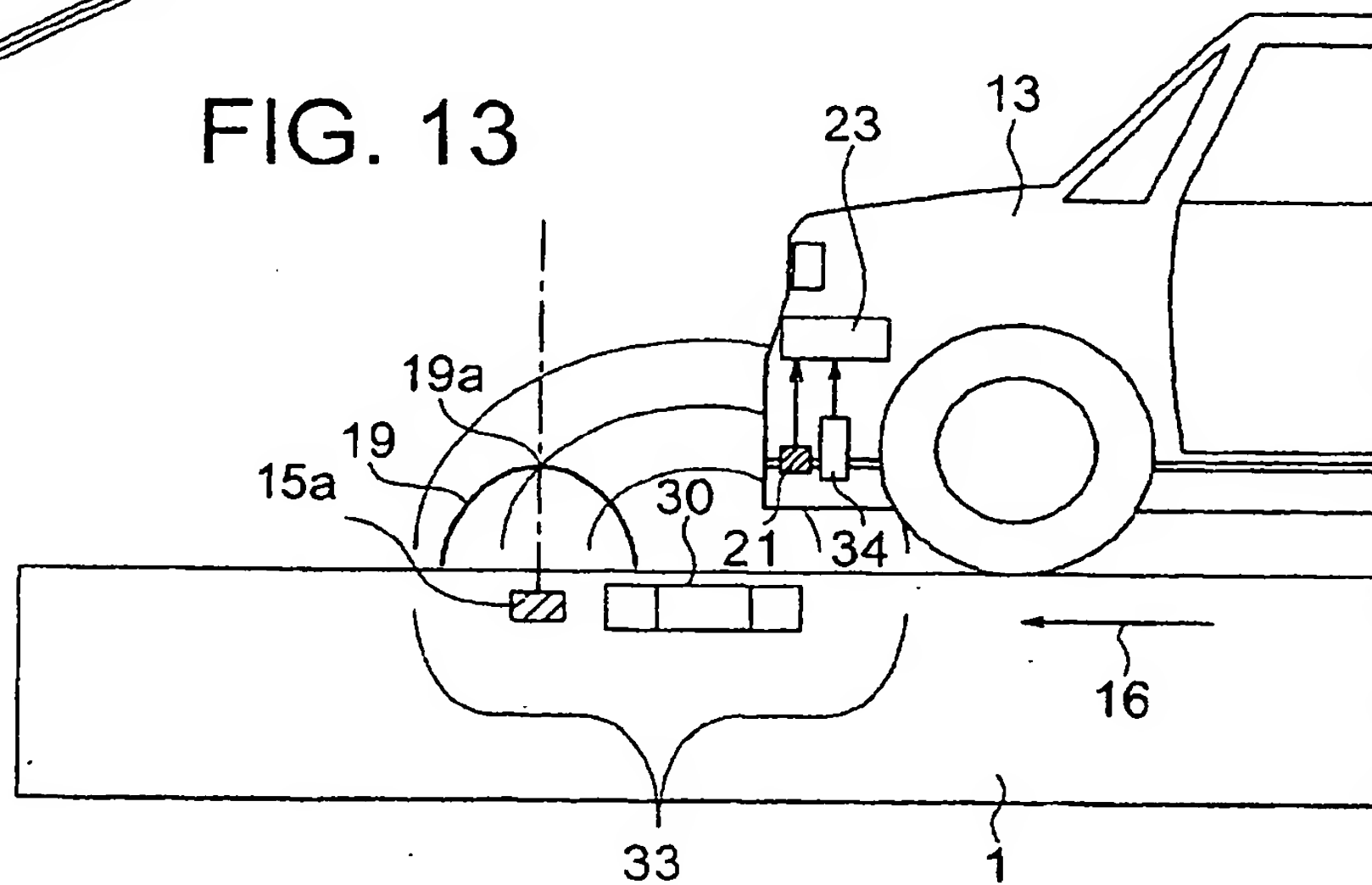


FIG. 14

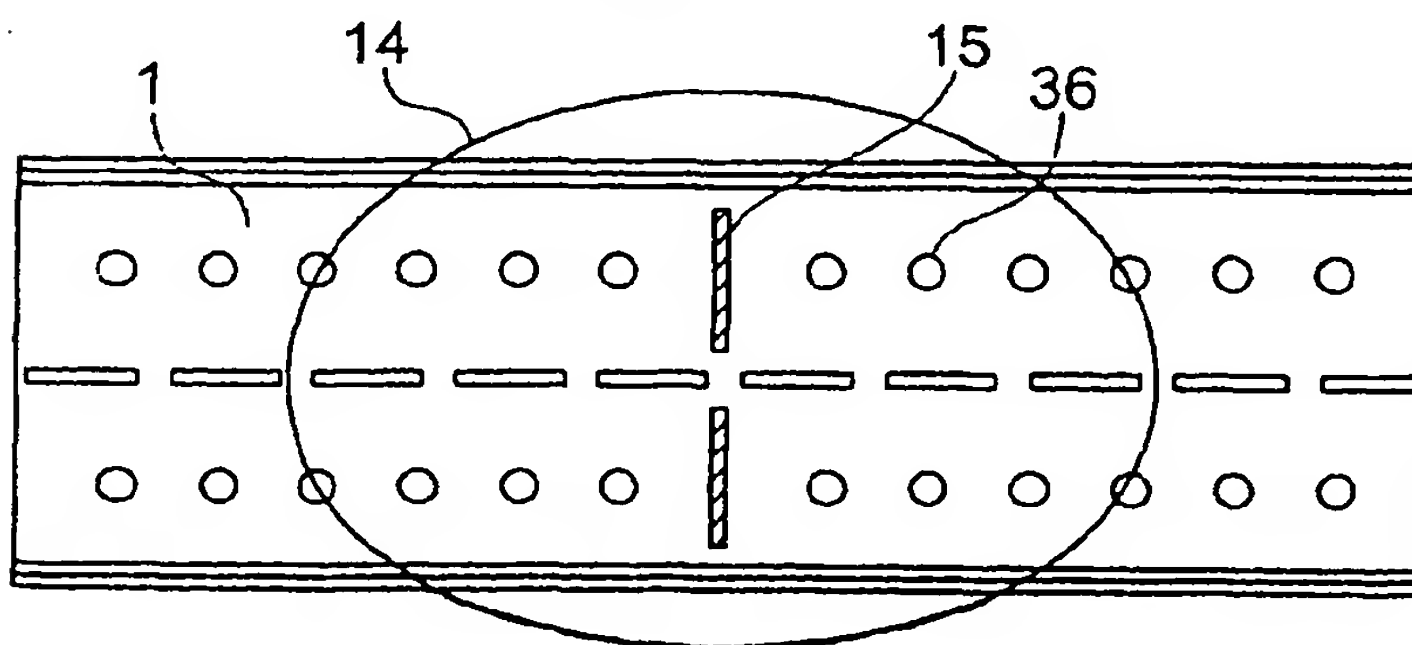


FIG. 15

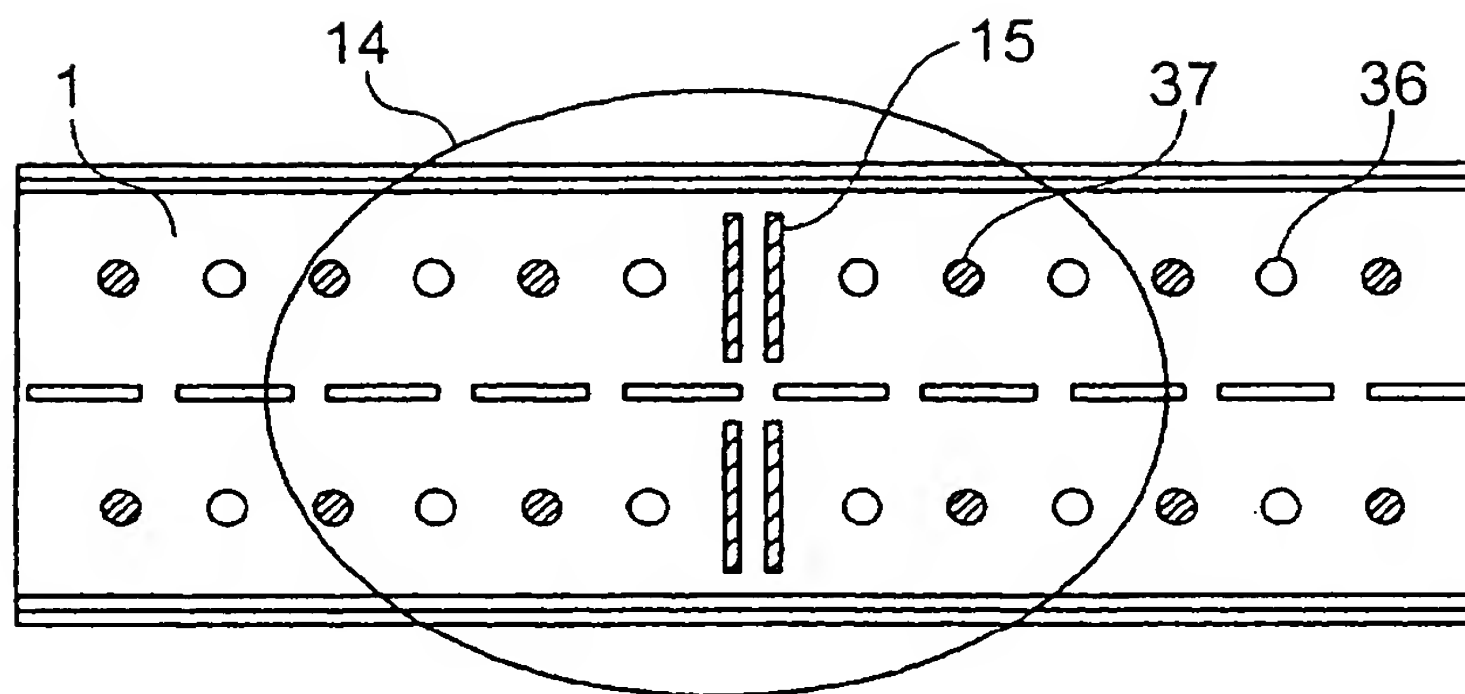


FIG. 16

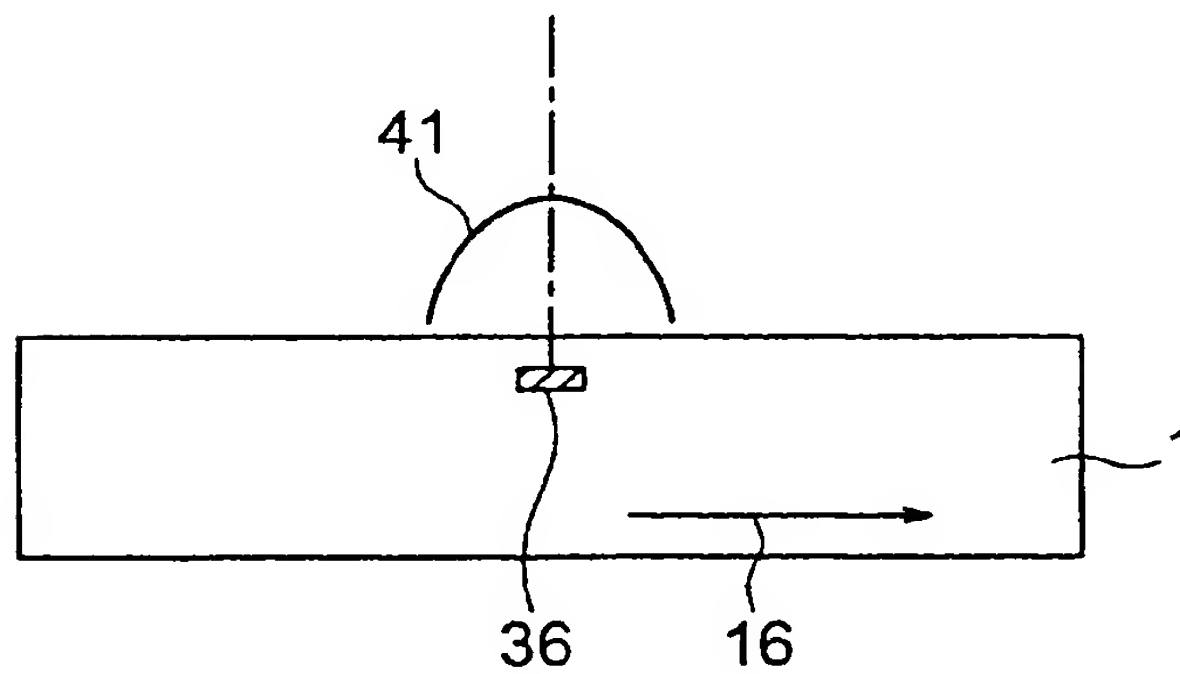


FIG. 17

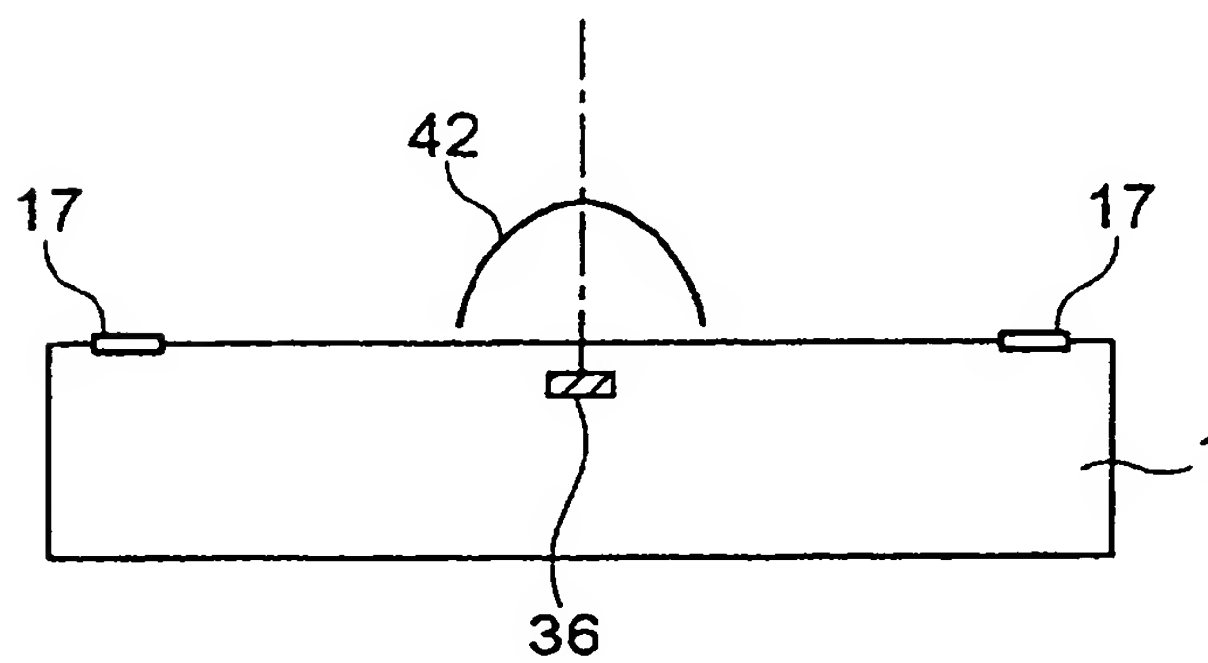


FIG. 18

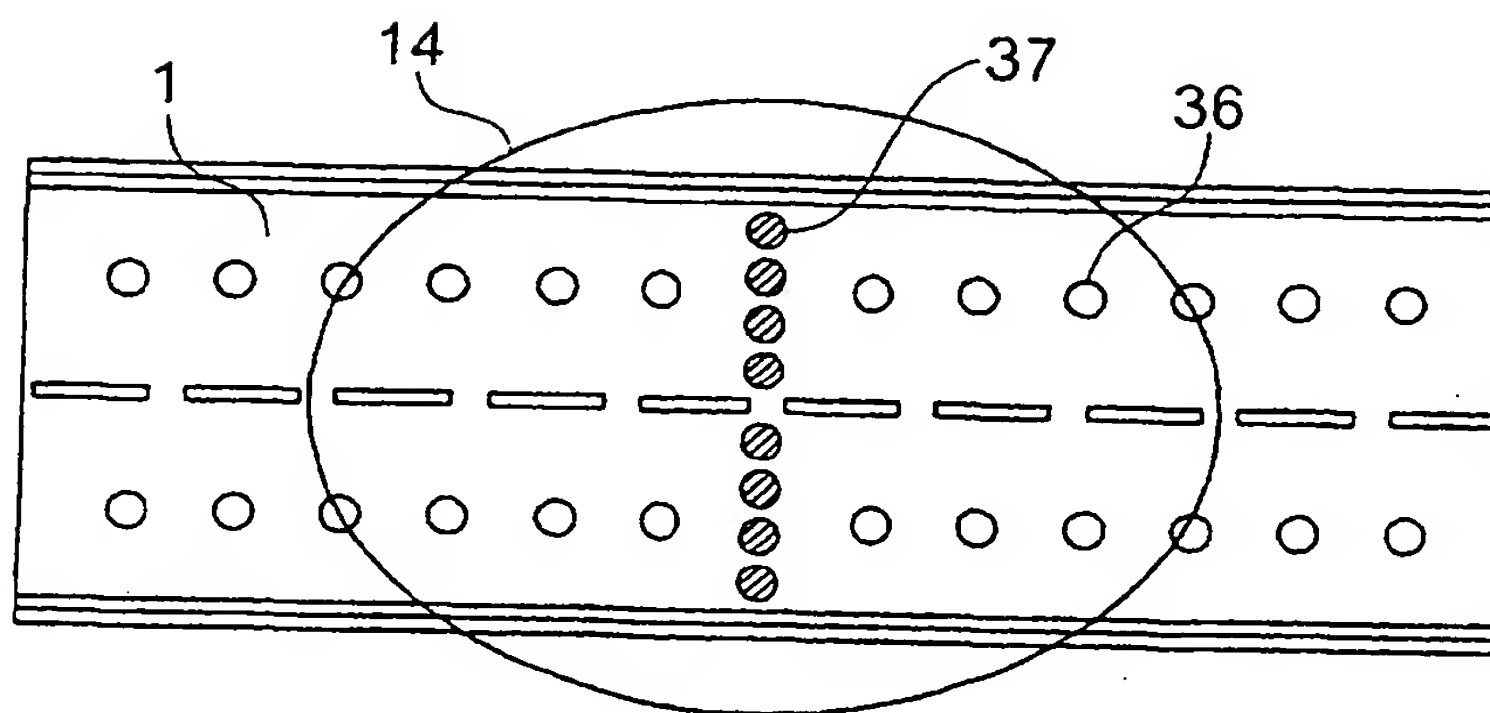


FIG. 19

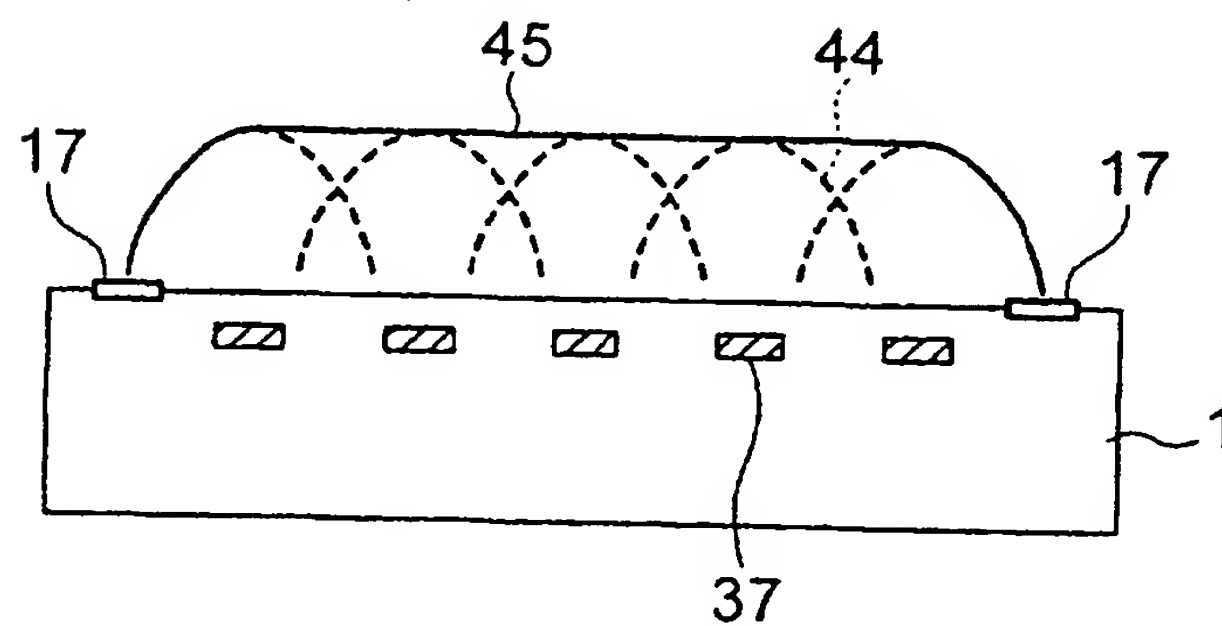
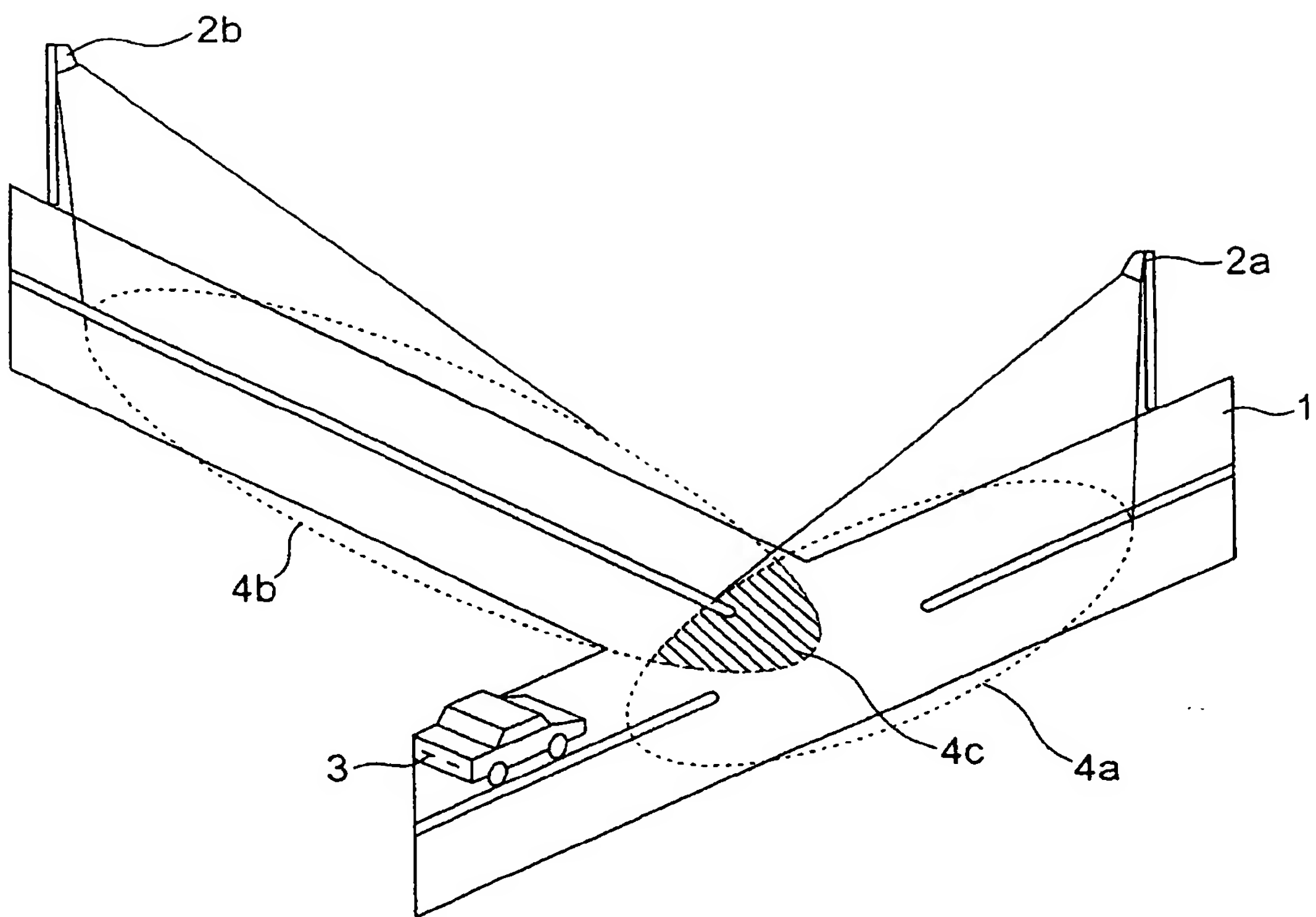


FIG. 20
PRIOR ART



(19)



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(72) Inventors:
• Oka, Kenichiro, c/o MNitsubishi Denki
Chiyoda-ku, Tokyo 100-8310 (JP)
• Suzuki, Hiroyoshi, c/o MNitsubishi Denki
Chiyoda-ku, Tokyo 100-8310 (JP)

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(74) Representative: Tothill, John Paul
Frank B. Dehn & Co.
179 Queen Victoria Street
London EC4V 4EL (GB)

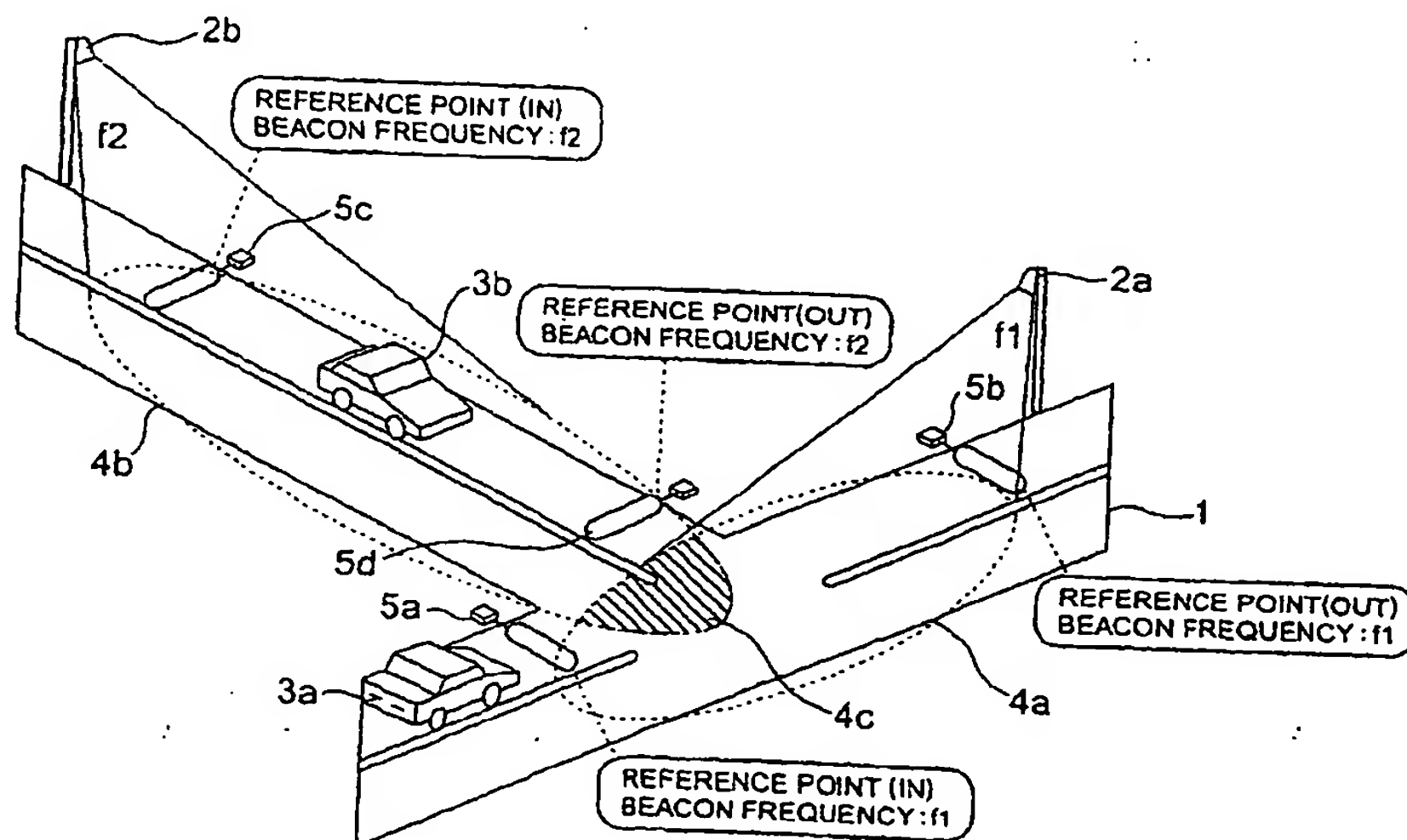
(71) Applicant: Director General of National Institute
for Land and Infrastructure Management,
Ministry of Land, Infrastructure and Transport
Tsukuba City, Ibaraki Prefecture 305-0804 (JP)

(54) On-road reference point positional data delivery device

(57) The on-road reference point positional data delivery device according to the present invention has a reference point positional data delivery means, and this reference point positional data delivery device has a

beacon identification means for indicating a reference point position for service information delivered from a beacon provided on a road to a vehicle and also selecting the beacon delivering the service information from among a plurality of beacons.

FIG. 1





European Patent
Office

EUROPEAN SEARCH REPORT

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EP 01 30 9880

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30 June 2003	Examiner Flores Jiménez, A
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